CHAPTER 5
Model Calibration

STEADY-STATE MODEL CALIBRATION

Calibration Criteria and Targets

Calibration Targets included the following:

- Surficial Aquifer System <= ±4ft between model input data (or avg. observed values for 1995) and simulated heads.
- Upper and Middle Floridan <= ±2.5ft between model input data (or avg. observed values for 1995) and simulated heads.
- Water Levels in Surficial Aquifer are not above land surface (except water bodies).
- Simulated Contours and heads in Upper and Middle Floridan are similar to shape and gradient of those from the average 1995 Upper Floridan Potentiometric Surface Map.

The calibration criteria for the Surficial Aquifer System are not as rigorous as for the other aquifers. It is difficult for MODFLOW to react to rapid elevation changes, which occur between adjacent cells, and most of the observation sites are located along surface water features and not in the ridge areas. The calibration targets were set using the same criteria as used in the SJRWMD East Central Floridan Model expansion and revision (McGurk and Presley 2002). The starting heads for the Surficial Aquifer System were estimated base on the topography and observation stations, but in areas with high topography the water level may be deeper than in the plains.

Calibration Process

In order to test the calibration targets, than the following methods were used:

1. A program compared the water level at observation sites to those simulated by the model.
2. In ArcGIS, the surface (GRID) of the starting heads in each layer was compared to water level surfaces (GRID) generated from the model output.
3. Contours were created for the previously mentioned surfaces and plotted on the same map as the target contour.

The Vcont values for the Intermediate Confining Unit were adjusted in an iterative fashion until the differences in between simulated and observed heads were minimized. The Vcont values were highest in sinkhole areas. For more details, see the Vertical Conductance section earlier in this document.

Calibration Locations

Observation site data were collected from the SFWMD DBHYDRO environmental database and the USGS National Water Information System database. Wells in the area without depth or casing information could not be used. Most of the wells only had seasonal observations. The observation wells for the calibration run were limited to those sites having observations in 1995. The depth of the well assigned to the hydrostratigraphy layers. Some of the wells had a listed a source aquifer in the database. This was compared to model layer to see if the depth of hydrostratigraphy matched the database assignment. If casing information was available and the well was open cased in more than one layer, the observation well was assigned to the lower of those layers. If the bottom of the well was in a confining unit the observation well was assigned to the aquifer above the confining unit. Since there were only 16 groundwater wells in Layer 1, surface water features were used to assist in the calibration of the Surficial Aquifer System. Headwater values from structures in the model area were used as observation points, supplemented with a few lake water level from DBHYDRO and from lake gauges in the SFWMD. A total of 62 observation sites were used in the Surficial Aquifer System (**Figure 70**). There are 14 observation wells in the Upper Floridan Aquifer (**Figure 71**) and 23 in the Middle Floridan Aquifer (**Figure 72**). There are no wells in the Lower Floridan Aquifer. For more information on observation sites, see **Appendix E**.

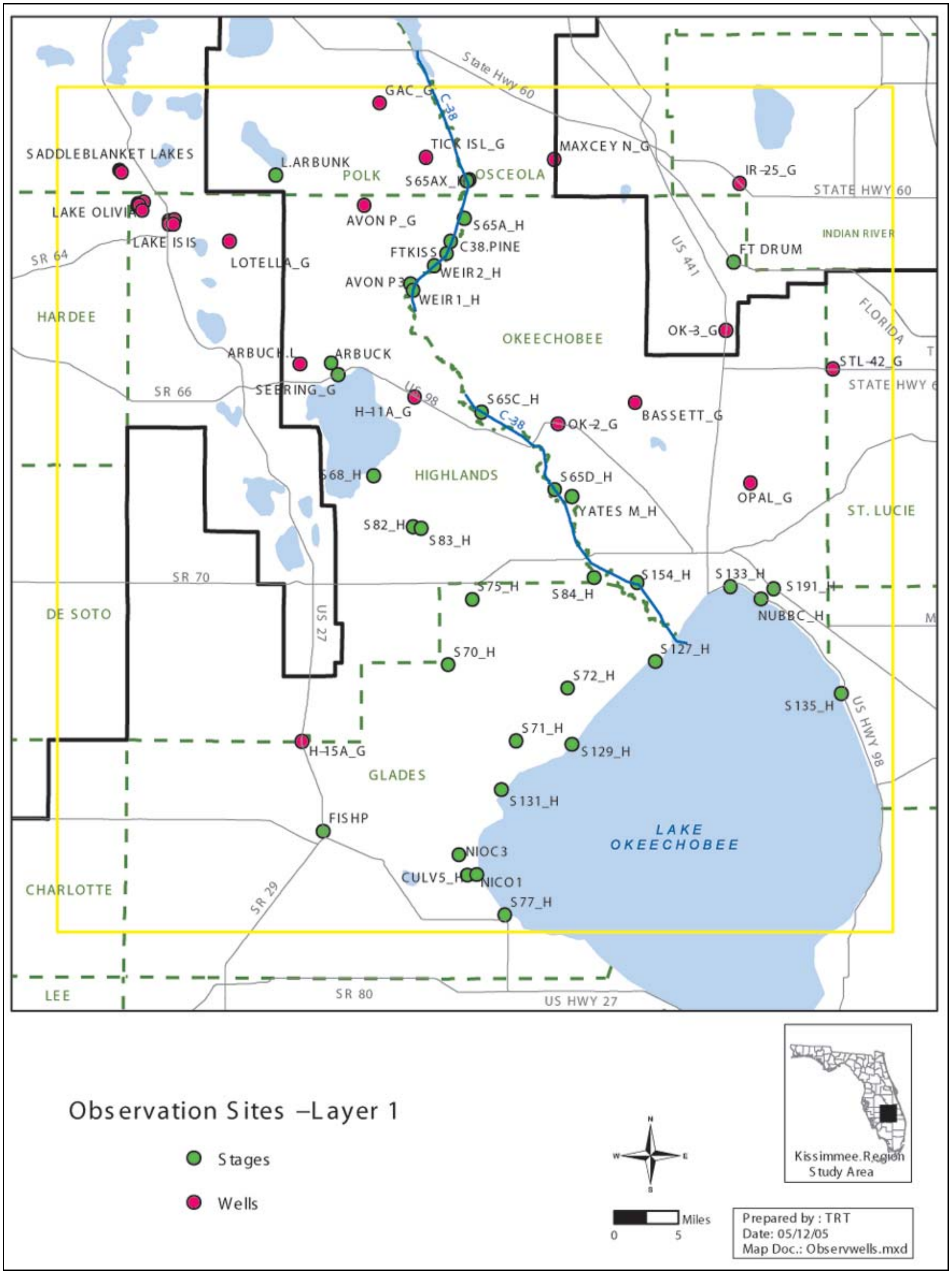

Figure 70. Observation Sites, Layer 1.

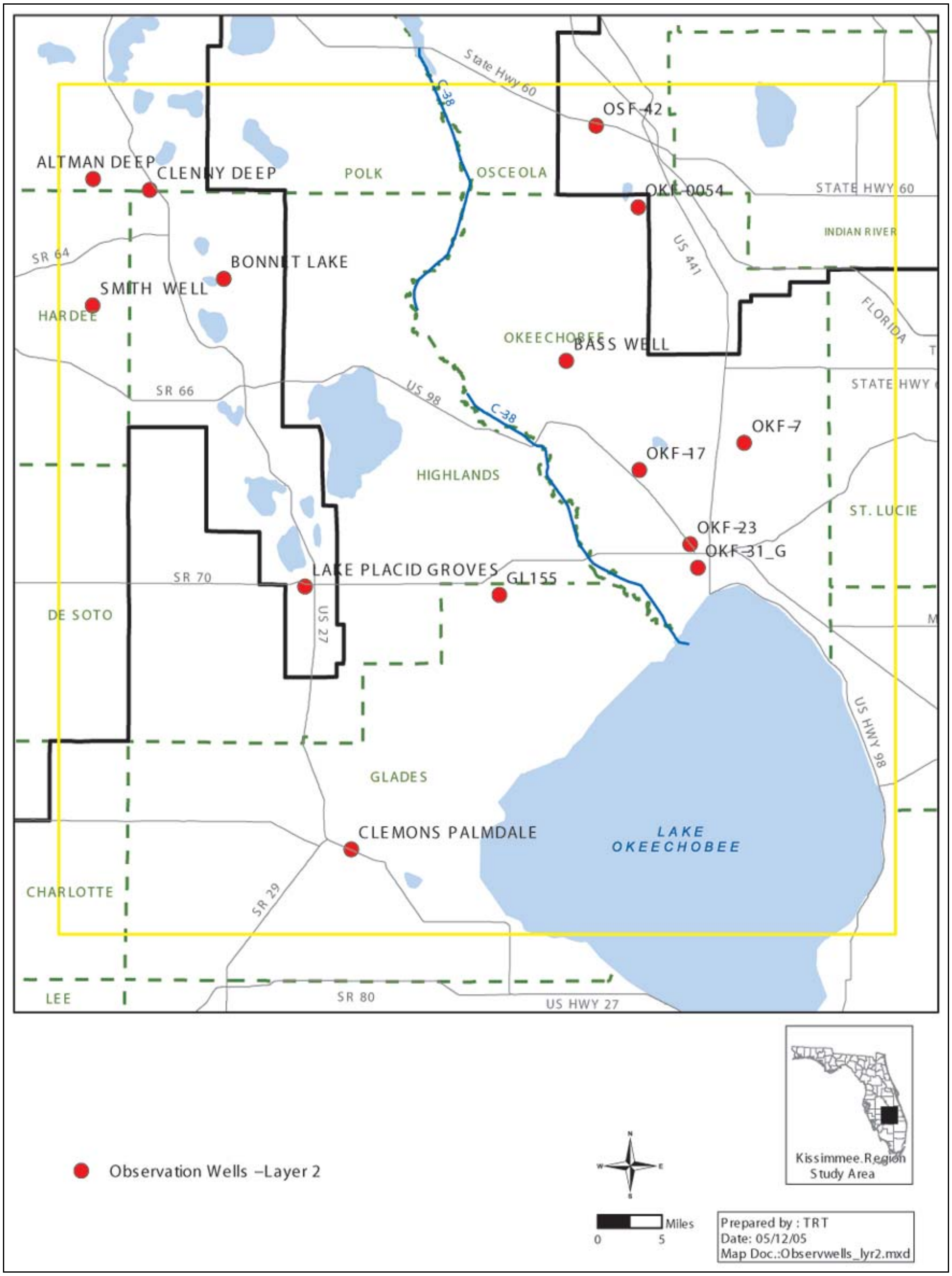

Figure 71. Observation Sites, Layer 2.

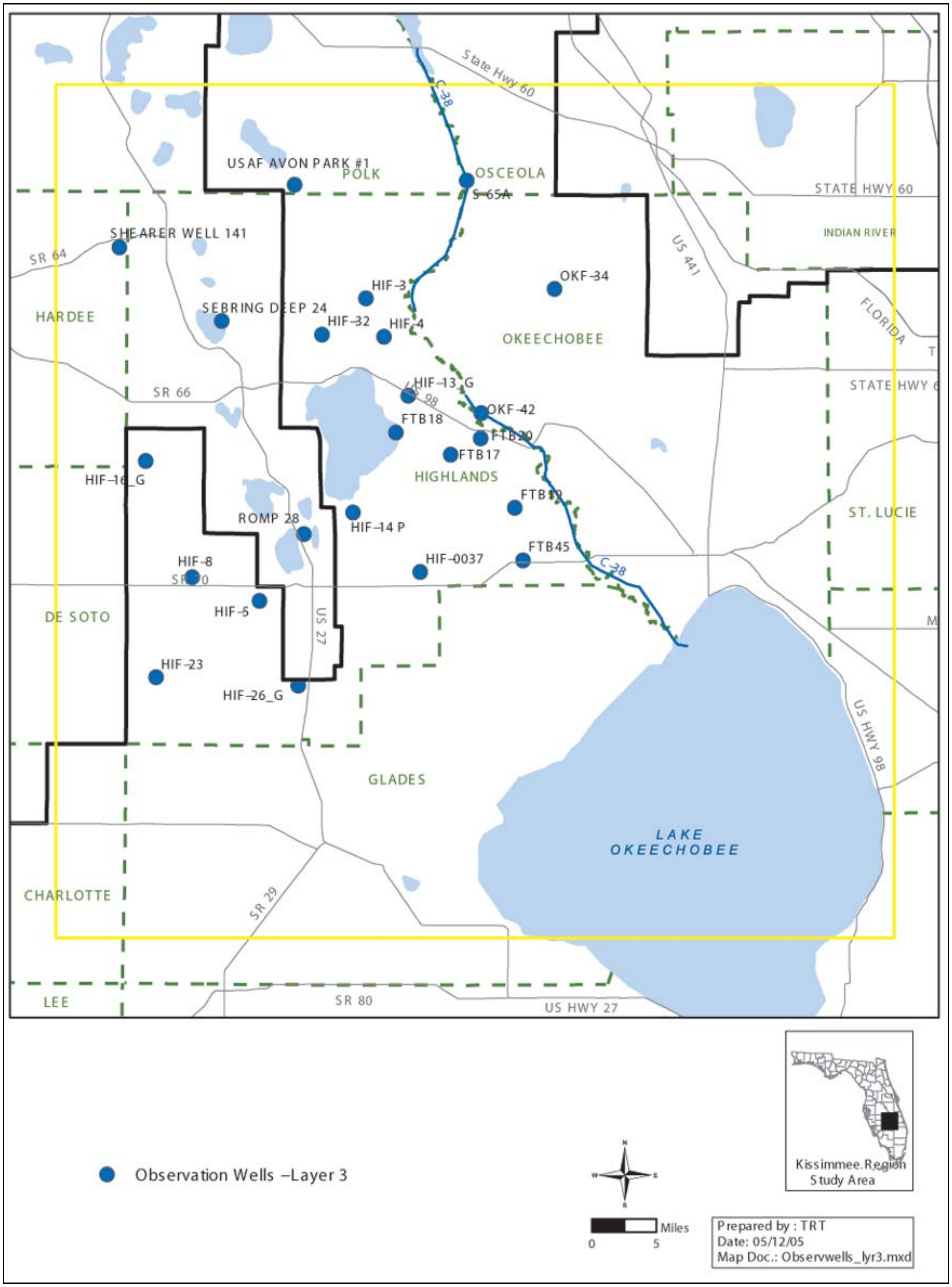

Figure 72. Observation Sites, Layer 3.

Calibration Results

The calibrated model produced simulated water levels, which are generally in agreement with observation values (**Table 16**, **Figures 73–77**). The weakest area for the model calibration in the Surficial Aquifer System was in the area near Avon Park Ridge. This area has rapid elevation changes from approximately 130 to approximately 80 feet in less than a mile. The other area that was difficult to calibrate was Lake Wales Ridge. Several of the lakes have a ring of monitoring wells around them. Saddle Blanket Lake has nine monitoring wells around it. MODFLOW will only allow one observation well per cell, so the observations of wells that fell within a cell were averaged to obtain the three observation values. The lakes were modeled as "river cells" so the water levels in the cell gravitated toward the given lake stage. In those cases where observation wells were further from the lake and the topography changed in a cell, it was not possible for all the modeled water levels to fall with the calibration criteria. A similar process was conducted to obtain the observation wells for Lake Olivia – 11 monitoring wells in five cells, and Lake Isis – nine monitoring wells in four cells (**Figure 78**, **Table 17**).

Table 16. Calibration Results Layer 1.

Station Name	Layer	Row	Col	Average 1995 Observed Water Level	Simulated Water Level	Difference in Water Levels	Met Calibration Criteria
GAC_G	1	3	51	60.79	56.28	4.51	
TICK ISL_G	1	11	58	48.85	52.34	-3.49	True
MAXCEY N_G	1	12	78	63.56	62.69	0.87	True
SADDLEBLANKET LAKES NORTH	1	13	10	118.91	111.24	7.67	
SADDLEBLANKET LAKES WEST	1	14	10	119.86	115.07	4.79	
SADDLEBLANKET LAKES EAST	1	14	11	121.34	116.51	4.83	
L.ARBUNK	1	14	34	54.44	53.00	1.44	True
S65A_H	1	15	64	46.33	41.99	4.34	
S65AX_H	1	15	65	46.40	45.52	0.88	True
IR-25_G	1	15	107	28.48	27.13	1.35	True
LAKE OLIVIA NORTH WEST	1	18	13	116.06	115.14	0.92	True
LAKE OLIVIA NORTH EAST	1	18	14	115.40	115.13	0.27	True
LAKE OLIVIA SOUTH WEST	1	19	13	117.73	115.14	2.59	True
LAKE OLIVIA SOUTH EAST	1	19	14	117.52	115.14	2.38	True
AVON P_G	1	19	48	128.78	114.14	14.64	
LAKE OLIVIA SOUTH	1	20	14	128.96	126.91	2.05	True
LAKE ISIS NORTH	1	21	18	112.66	112.66	0.00	True
LAKE ISIS EAST	1	21	19	110.99	111.22	-0.23	True

Table 16. Calibration Results Layer 1 (Continued).

Station Name	Layer	Row	Col	Average 1995 Observed Water Level	Simulated Water Level	Difference in Water Levels	Met Calibration Criteria
C38.PINE	1	21	64	43.08	44.08	-1.00	True
LAKE ISIS SOUTH	1	22	18	118.42	118.42	0.00	True
LAKE ISIS SOUTH EAST	1	22	19	114.85	114.05	0.80	True
LOTELLA_G	1	24	27	81.38	83.13	-1.75	True
FTKISS	1	24	62	42.31	41.81	0.50	True
WEIR3_H	1	26	61	42.24	42.37	-0.13	True
FT DRUM	1	27	106	35.53	34.76	0.77	True
WEIR2_H	1	28	59	41.95	41.84	0.11	True
AVON P3	1	31	55	41.71	40.90	0.81	True
WEIR1_H	1	32	56	41.39	41.39	0.00	True
OK-3_G	1	38	105	59.53	61.94	-2.41	True
SEBRING_G	1	43	38	55.86	58.65	-2.79	True
ARBUCK.L	1	43	43	40.16	41.98	-1.82	True
STL-42_G	1	44	121	25.79	25.30	0.49	True
ARBUCK	1	45	44	39.75	39.92	-0.17	True
H-11A_G	1	48	56	47.95	45.95	2.00	True
BASSETT_G	1	49	90	43.14	45.20	-2.06	True
S65C_H	1	51	67	33.81	33.49	0.32	True
OK-2_G	1	52	78	44.67	40.96	3.71	True
S68_H	1	60	50	39.12	39.12	0.00	True
OPAL_G	1	61	108	33.14	32.37	0.77	True
S65D_H	1	62	78	26.74	26.76	-0.02	True
YATES M_H	1	64	81	24.37	26.44	-2.07	True
S82_H	1	68	56	31.87	30.99	0.88	True
S83_H	1	68	57	31.97	34.31	-2.34	True
S84_H	1	76	84	24.71	23.22	1.49	True
S154_H	1	77	91	20.28	19.19	1.09	True
S133_H	1	77	105	13.57	13.57	0.00	True
NUBBC_H	1	78	112	19.36	18.98	0.38	True
S75_H	1	79	65	25.78	25.64	0.14	True
S191_H	1	79	110	19.12	19.12	0.00	True
S70_H	1	89	61	25.76	25.30	0.46	True

Table 16. Calibration Results Layer 1 (Continued).

Station Name	Layer	Row	Col	Average 1995 Observed Water Level	Simulated Water Level	Difference in Water Levels	Met Calibration Criteria
S127_H	1	89	94	13.56	13.56	0.00	True
S72_H	1	93	80	20.77	19.18	1.59	True
S135_H	1	94	122	13.60	13.60	0.00	True
H-15A_G	1	101	39	58.04	54.62	3.42	True
S71_H	1	101	72	19.92	18.28	1.64	True
S129_H	1	102	81	13.06	13.06	0.00	True
S131_H	1	109	70	13.04	13.04	0.00	True
FISHP	1	115	42	31.25	30.48	0.77	True
NIOC3	1	119	63	17.99	17.92	0.07	True
NICO1	1	122	64	13.99	12.07	1.92	True
CULV5_H	1	122	66	16.52	16.52	0.00	True
S77_H	1	128	70	16.39	16.39	0.00	True
					Average Difference	0.93	
					Count Calibrated	56	
					% Calibrated	90.32%	

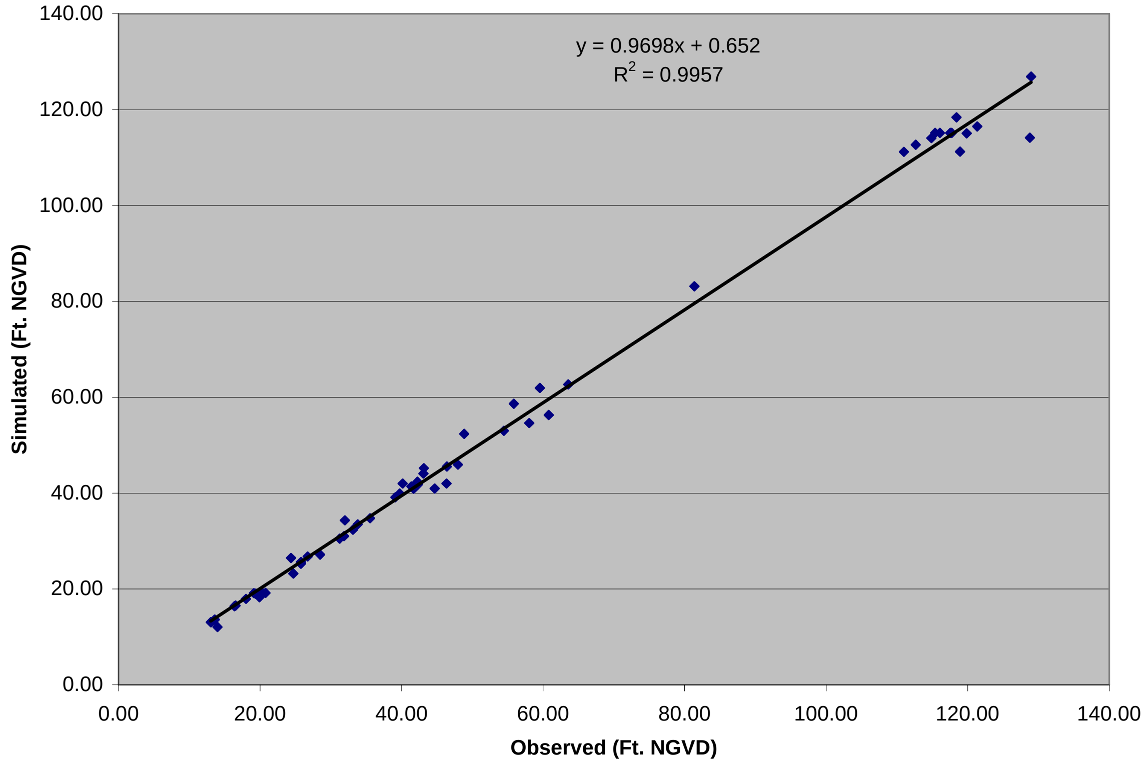

Figure 73. Observed Versus Simulated Layer 1 (Surficial Aquifer System) Water Levels, Average 1995 Conditions.

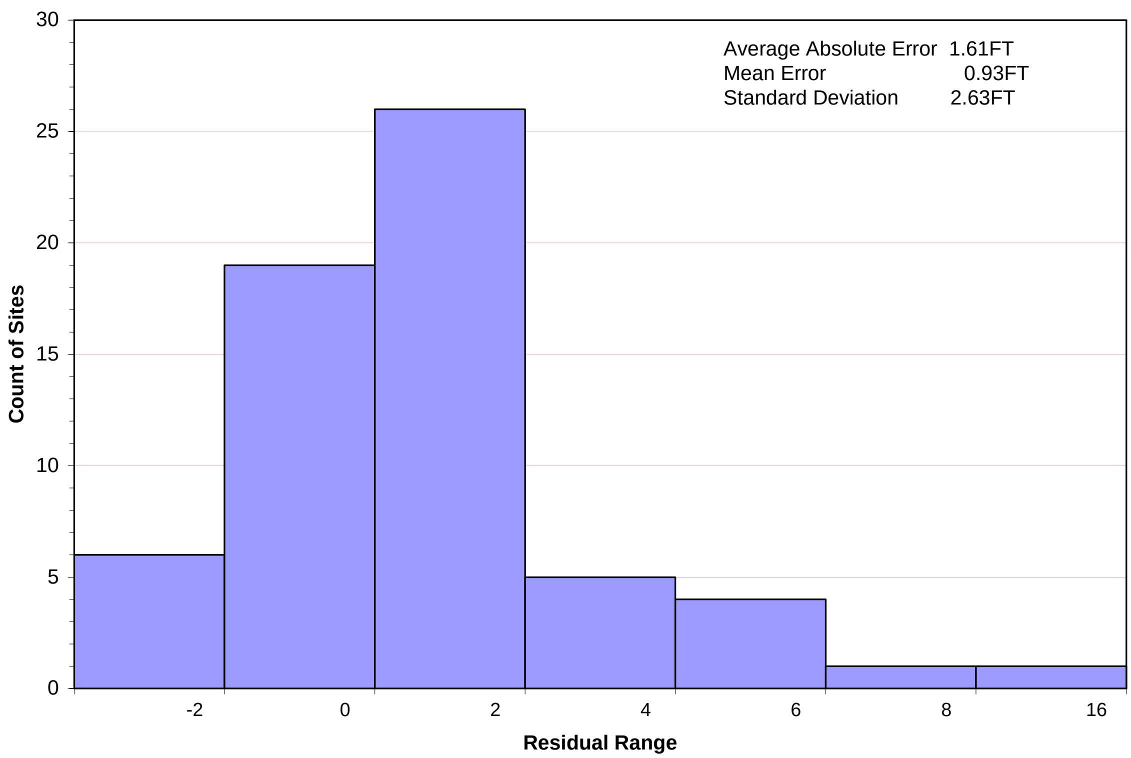

Figure 74. Layer 1 Water Level Residuals for 1995 Calibration.

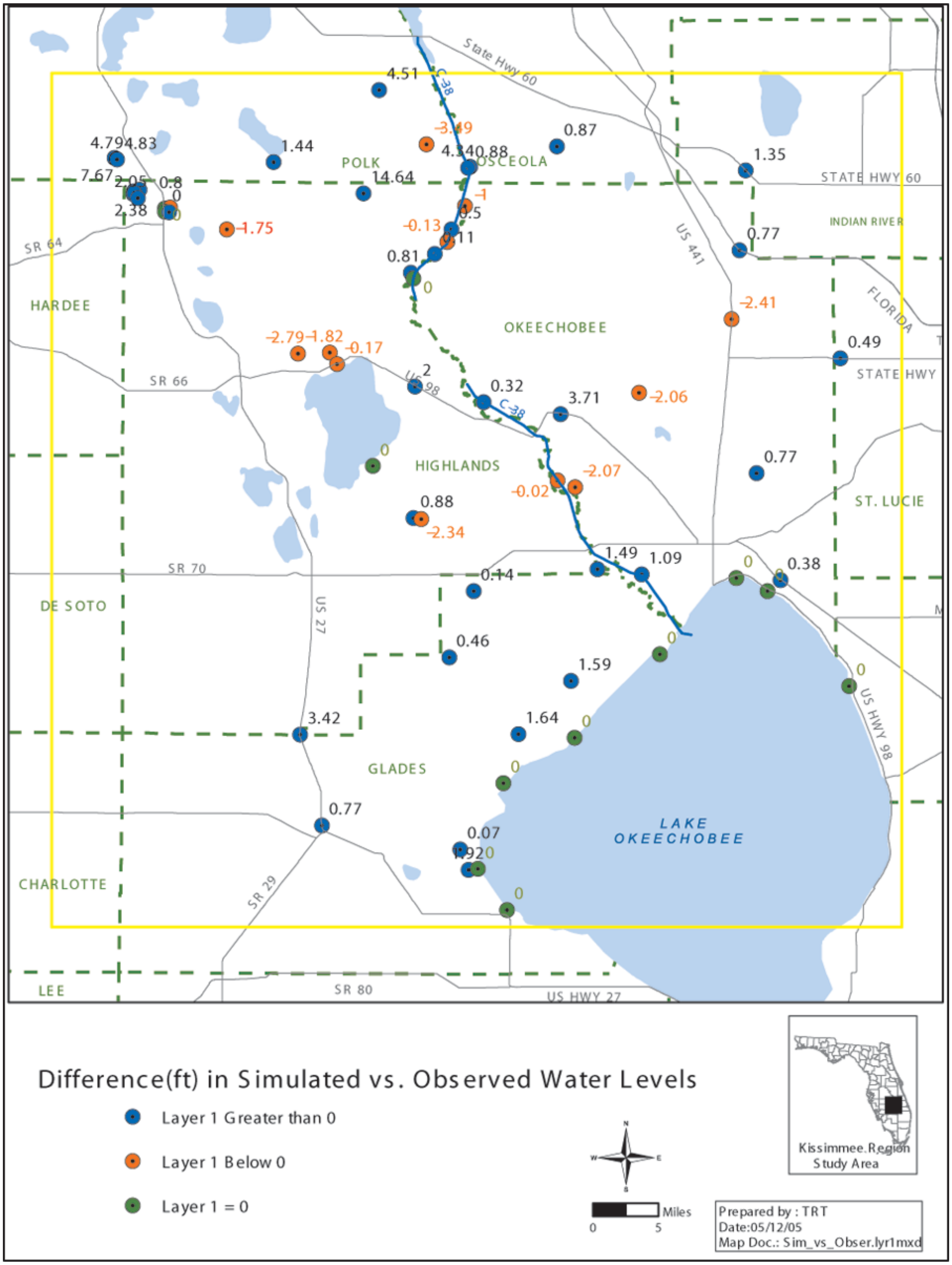

Figure 75. Layer 1 Water Level Residuals for 1995 Calibration (Map).

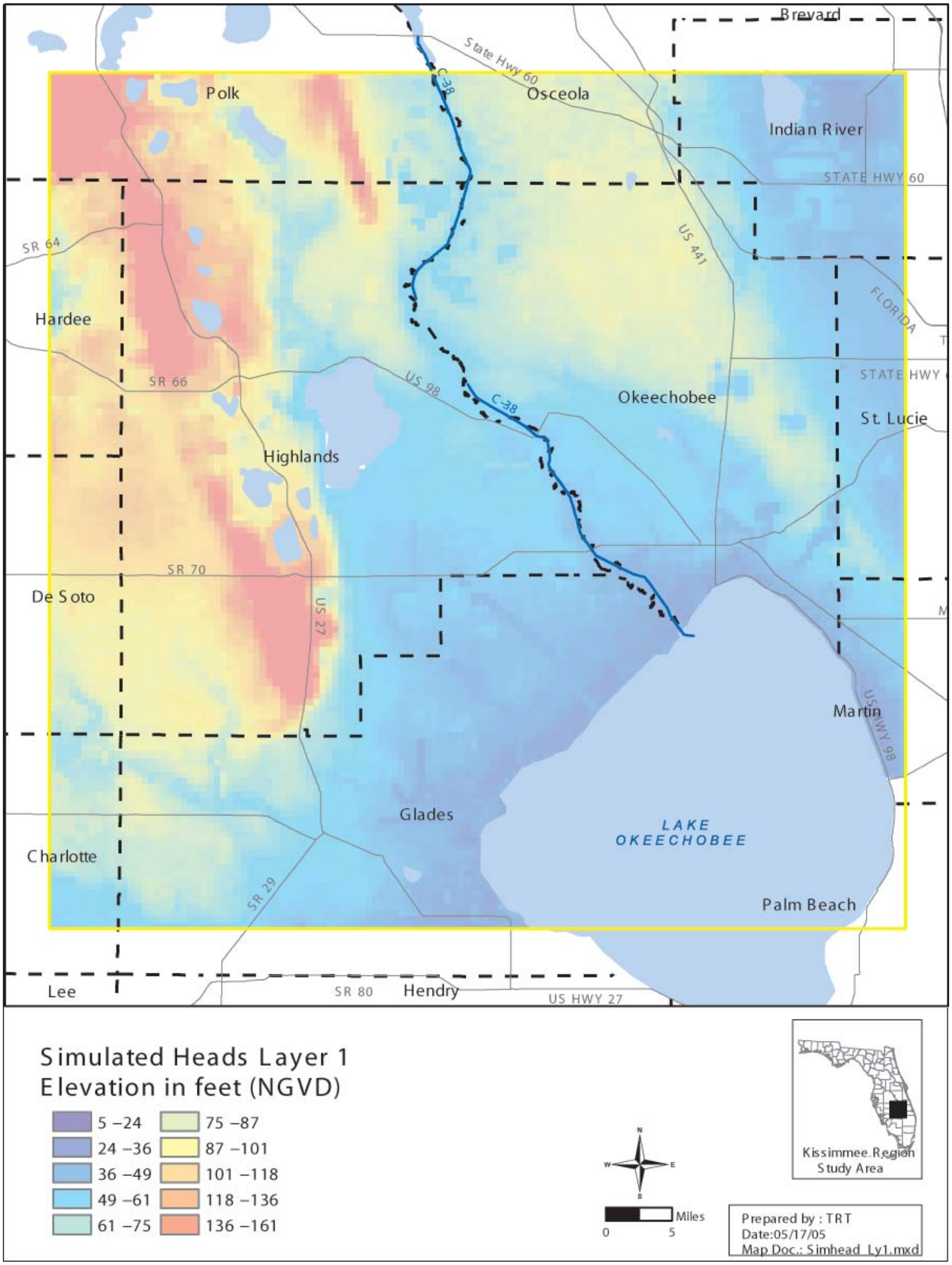

Figure 76. Simulated Heads Layer 1 (Elevation in ft NGVD).

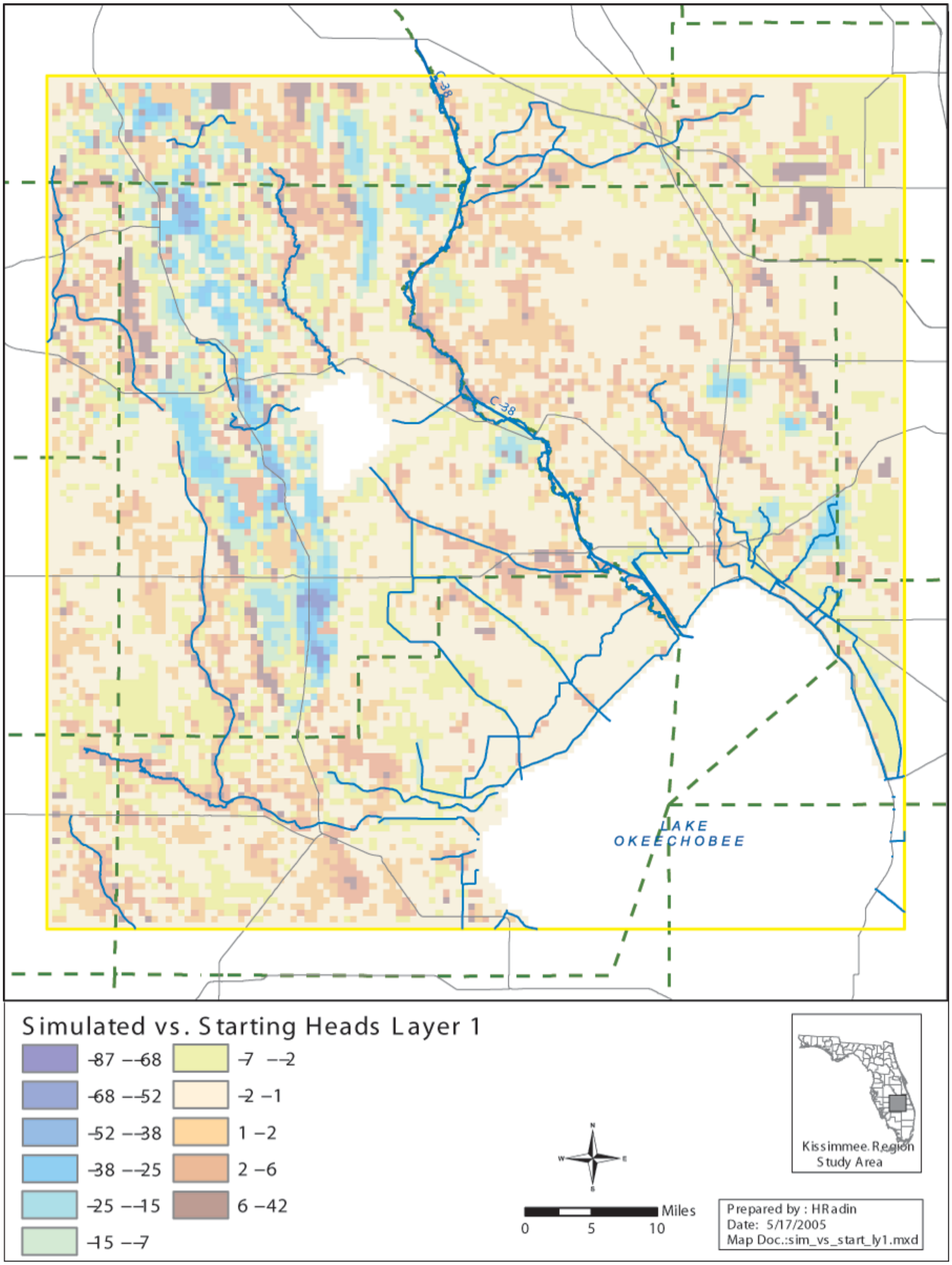

Figure 77. Difference in Simulated vs. Starting Head Water Levels (Map).

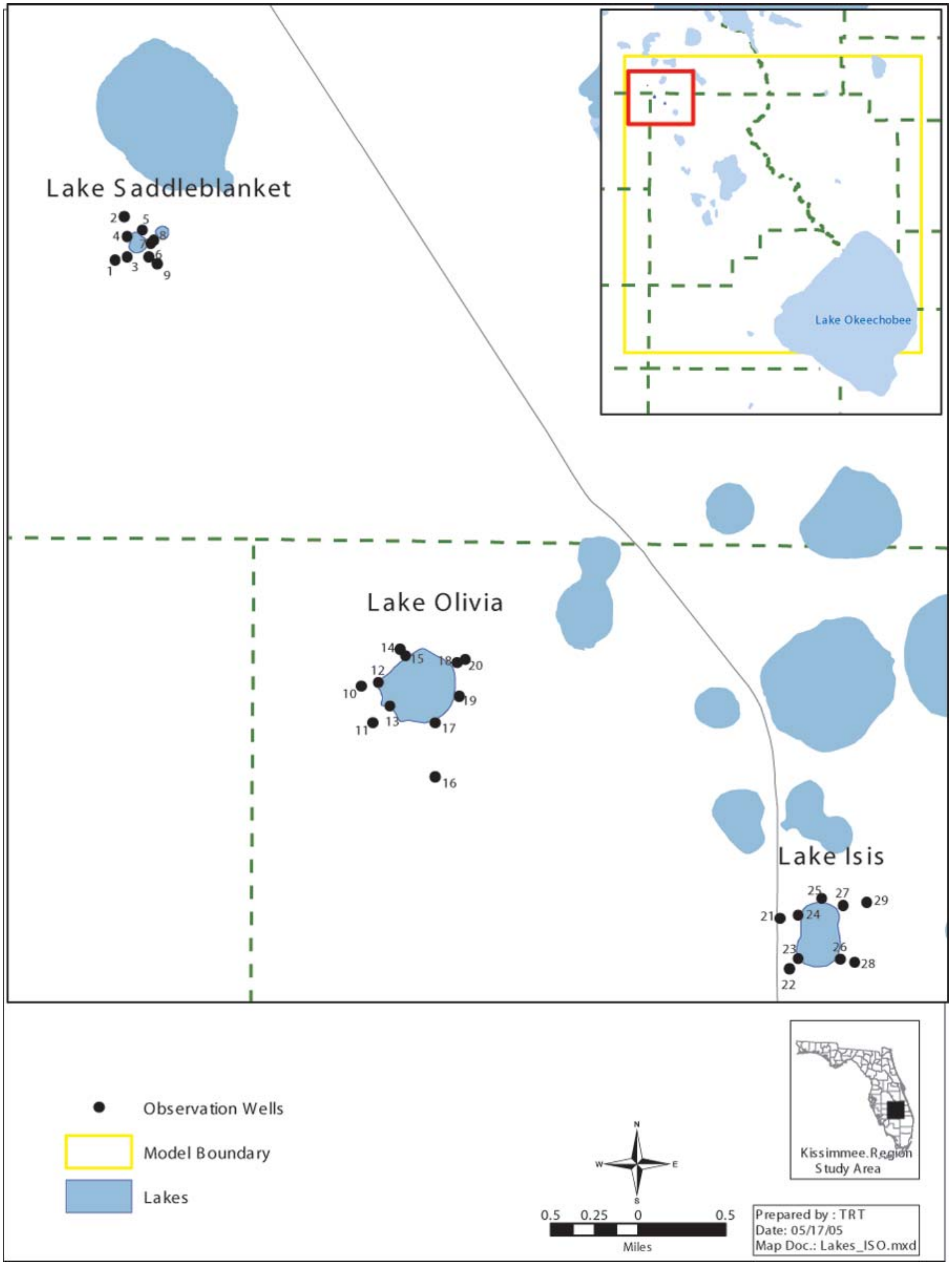

Figure 78. Inset with Lake Isis, Saddle Blanket and Lake Olivia.

Table 17. List of Observation Wells near Lake Isis, Saddle Blanket and Lake Olivia.

Number	Station	Total Depth BLS in Feet	Average Water Level
1	SADDLEBLANKET LKS SBUSW NRSD W NEAR FRO	19	120.61
2	SADDLEBLANKET LAKES SBUN NRSD W NEAR FR	19	118.83
3	SADDLEBLANKET LKS SBLSW NRSD W NEAR FRO	14	119.36
4	SADDLEBLANKET LKS SBLNW NRSD W NEAR FRO	14	118.92
5	SADDLEBLANKET LAKES SBLN NRSD W NEAR FR	10	119.27
6	SADDLEBLANKET LKS SBLSE NRSD W NEAR FRO	10	119.61
7	SADDLEBLANKET LKS SBLNE NRSD W NEAR FRO	18	119.14
8	SADDLEBLANKET LKS SBUNE NRSD W NEAR FRO	15	118.40
9	SADDLEBLANKET LKS SBUSE NRSD W NEAR FRO	27	121.34
10	LAKE OLIVIA OLUW NRSD WELL NEAR AVON PA	20	115.73
11	LAKE OLIVIA OLUSW NRSD WELL NEAR AVON P	25	118.67
12	LAKE OLIVIA OLLW NRSD WELL NEAR AVON PA	12	116.42
13	LAKE OLIVIA OLLSW NRSD WELL NEAR AVON P	15	116.79
14	LAKE OLIVIA OLUNW NRSD WELL NEAR AVON P	18	116.37
15	LAKE OLIVIA OLLNW NRSD WELL NEAR AVON P	14	115.71
16	LAKE OLIVIA OLUS NRSD WELL NEAR AVON PA	30	128.96
17	LAKE OLIVIA OLLS NRSD WELL NEAR AVON PA	15	118.18
18	LAKE OLIVIA OLLNE NRSD WELL NEAR AVON P	16	115.92
19	LAKE OLIVIA OLLE NRSD WELL NEAR AVON PA	12	116.86
20	LAKE OLIVIA OLUNE NRSD WELL NEAR AVON P	13	114.87
21	LAKE ISIS ISUNW NRSD WELL AT AVON PARK	38	115.63
22	LAKE ISIS ISUSW NRSD WELL AT AVON PARK	25	124.44
23	LAKE ISIS ISLSW NRSD WELL AT AVON PARK	10	118.28
24	LAKE ISIS ISLNW NRSD WELL AT AVON PARK	25	112.71
25	LAKE ISIS ISLN NRSD WELL AT AVON PARK F	23	110.77
26	LAKE ISIS ISLSE NRSD WELL AT AVON PARK	13	112.54
27	LAKE ISIS ISLNE NRSD WELL AT AVON PARK	19	111.54
28	LAKE ISIS ISUSE NRSD WELL AT AVON PARK	35	114.85
29	LAKE ISIS ISUNE NRSD WELL AT AVON PARK	25	110.99

It was more difficult to evaluate areas where the observation sites were scarce. The Vcont values for the Intermediate Aquifer were adjusted so “pooling” of water above land surface in the Surficial Aquifer System was minimized and concentrated in marsh and wetland areas or along waterways (**Figure 79**). When comparing the simulated water surface to the starting heads for the Surficial Aquifer System, it was assumed that if the water levels fell within the Surficial Aquifer System and the observation points calibrated the surface was a good approximation of reality. In most areas, the water levels were deeper than the starting heads, which were set at 1 foot bls (**Figure 50**). The simulated water levels were deepest below the areas with the highest elevations. The average difference between observed and simulated water levels in the Surficial Aquifer System is 0.93 feet, with 56 of the 63 observation site meeting the criteria of 4 feet or less.

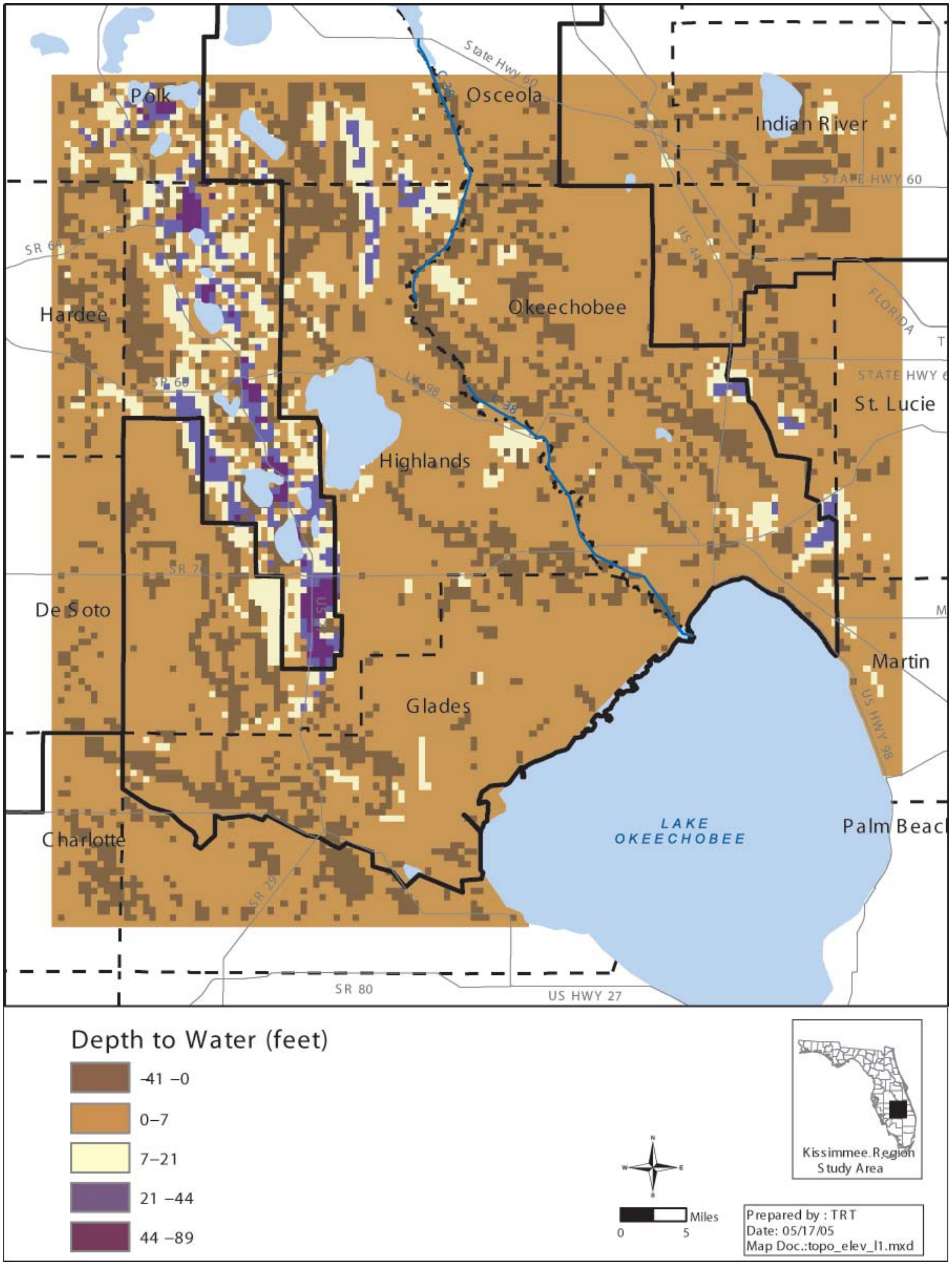

Figure 79. Depth to Water (Simulated Layer 1 Water Levels) for Average 1995 Conditions.

Water levels in the Upper Floridan Aquifer (**Figure 80**) and the Middle Floridan Aquifer (**Figure 81**) were both compared to one surface that was generated from the 1995 potentiometric maps (Knowles 1995). The potentiometric maps did not distinguish between wells in the Upper Floridan Aquifer and Middle Floridan Aquifer, but monitored them as one unit. As seen in Romp28 most of water levels in the Middle Floridan Aquifer are very similar to those in the Upper Floridan Aquifer. **Figure 82** shows the difference in the simulated water levels in Layer 2 and 3. The average head difference is 0.2 feet. Only two wells out of 14 in the Upper Floridan Aquifer did not meet the calibration criteria of within 2.5 feet (**Figure 88**), and OKF31 missed the target value by just 0.01 feet (**Table 18**). In the Middle Floridan Aquifer, only one well out of 23, HIF16 (**Figure 92**), did not fall in the calibration range. HIF16 is located southwest of the Lake Wales Ridge (**Table 19**).

The contours for the simulated heads from the Upper (**Figure 80**) and Middle (**Figure 81**) Floridan Aquifer match well with those from the average 1995 water levels in Upper Floridan Aquifer. The contours from Layer 3 (Middle Floridan Aquifer) are a better match than those from Layer 2) (Upper Floridan Aquifer). In the Upper Floridan Aquifer, the 60-foot contour deviates too far south, south of the Lake Wales Ridge. Attempts to modify the transmissivities south of the ridge did not improve the calibration, so the transmissivities were returned to the original values obtained from (Reese and Richardson 2004). It is apparent the flow along the ridge is faster than the flow off of the ridge toward the southwest.

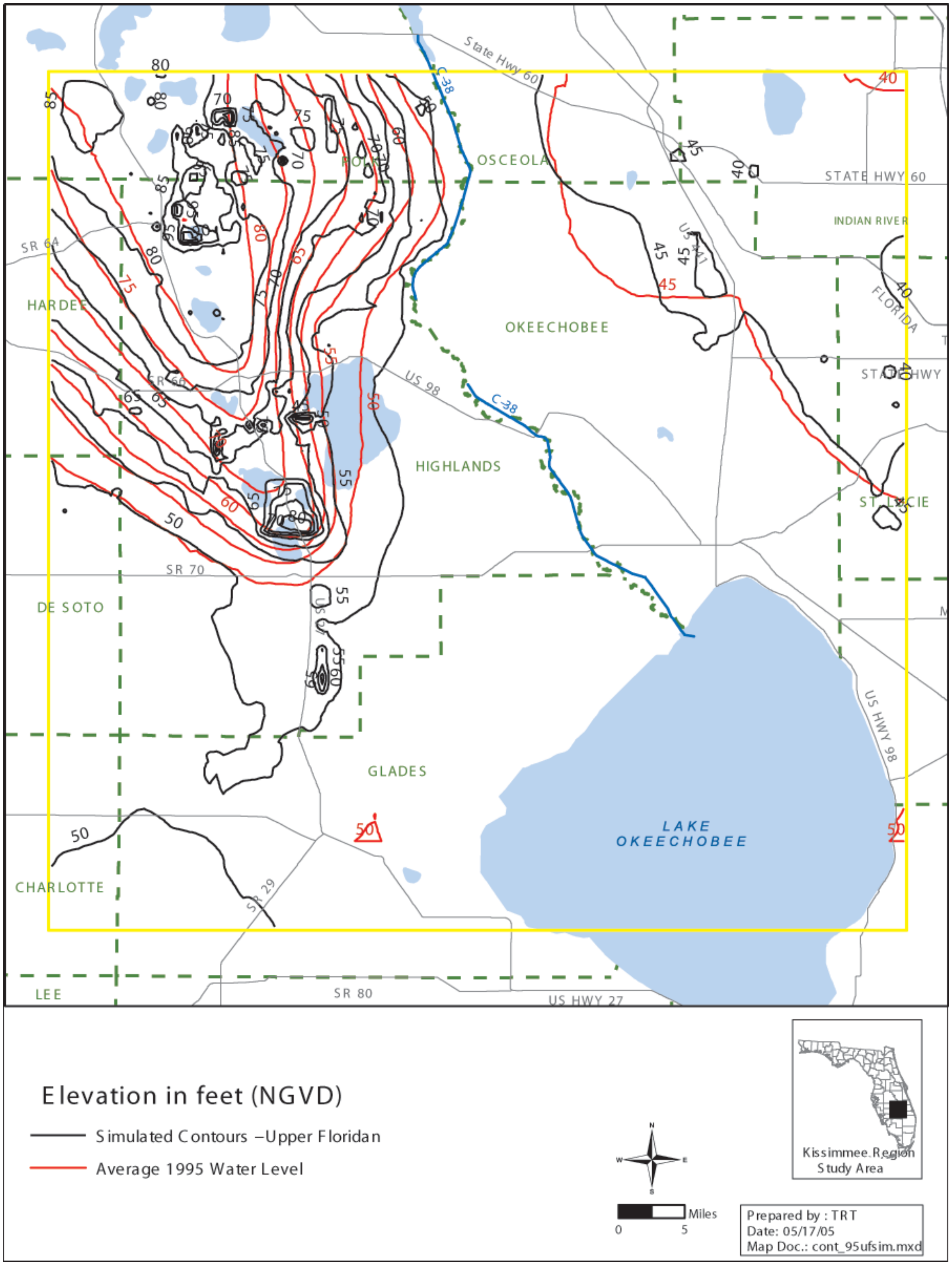

Figure 80. Contours Simulated Upper Floridan vs. Average 1995 Water Levels in Upper Floridan.

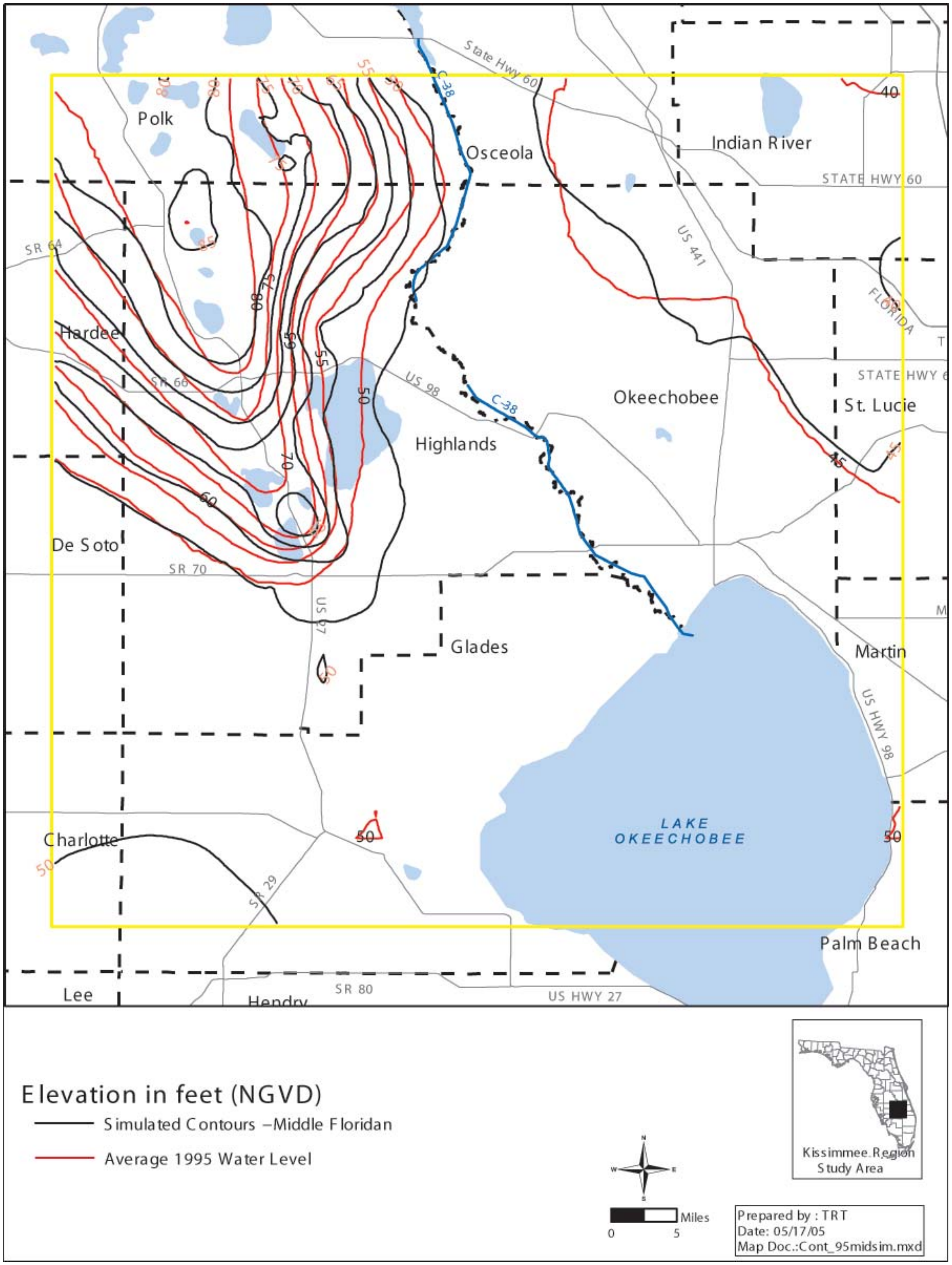

Figure 81. Contours Simulated Middle Floridan vs. Average 1995 Water Levels in Upper Floridan.

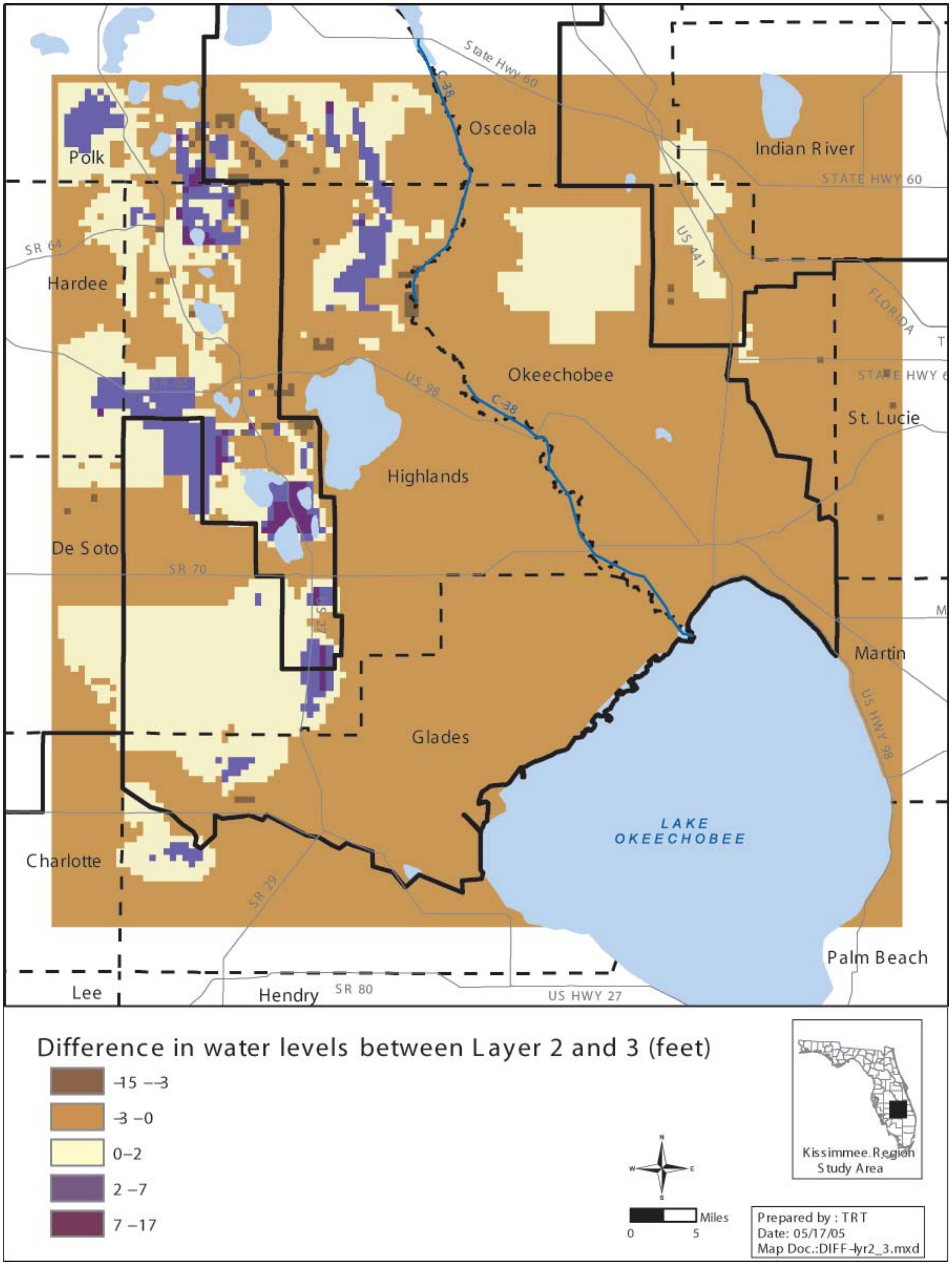

Figure 82. Difference between Water Levels in Layers 2 and 3.

Table 18. Calibration Results Layer 2.

Station Name	Layer	Row	Col	Average 1995 Observed Water Level	Simulated Water Level	Difference in Water Levels	Met Calibration Criteria
OSF-42	2	7	84	43.02	42.92	0.10	True
ALTMAN DEEP WELL NEAR WEST FROSTPROOF FL	2	15	6	84.20	83.39	0.81	True
CLENNY DEEP NW/O AVON PK FL	2	17	15	83.05	81.29	1.76	True
OKF-0054	2	19	91	39.08	43.08	-4.00	
BONNET LAKE DEEP NEAR SEBRING	2	30	26	83.21	82.38	0.83	True
SMITH DEEP WELL NO. 731136344333 NR LEMON GROVE FL	2	34	6	71.64	70.29	1.35	True
727100-- 35S33E02 BASS WELL N OF BASSINGER (okf18)	2	43	79	46.73	46.73	0.00	True
OKF-7	2	55	107	46.19	45.79	0.40	True
OKF-17 DIXIE RANCH	2	59	91	47.00	46.50	0.50	True
OKF-23	2	71	99	44.34	46.75	-2.41	True
OKF-31_G	2	74	100	49.85	47.34	2.51	
LAKE PLACID GROVES DEEP SOUTH OF LAKE PLACID FL	2	77	39	51.19	52.16	-0.97	True
71110501OBSER WELL GL155 NEAR BRIGHTON, FL.	2	79	69	48.01	47.37	0.64	True
65411601 41S30E12 CLEMONS PALMDALE	2	117	46	49.90	49.48	0.42	True
					Average Difference	1.12	
					Count Calibrated	12	
					% Calibrated	85.71%	

The simulated heads in Layers 2 and 3 were usually within ±2.5 feet of the starting heads (**Figures 85**, **89**). The starting heads were the average 1995 water levels. In areas that did not have observation points, it was difficult to calibrate.

The simulated water levels for the Upper Floridan Aquifer are very close to the observed values with a trend line of R^2=0.99 (**Figures 86** and **87**). The simulated water levels for the Middle Floridan Aquifer have a trend line of R^2=0.98. When compared to observations sites, the mean error was only 0.17 feet (**Figures 90** and **91**).

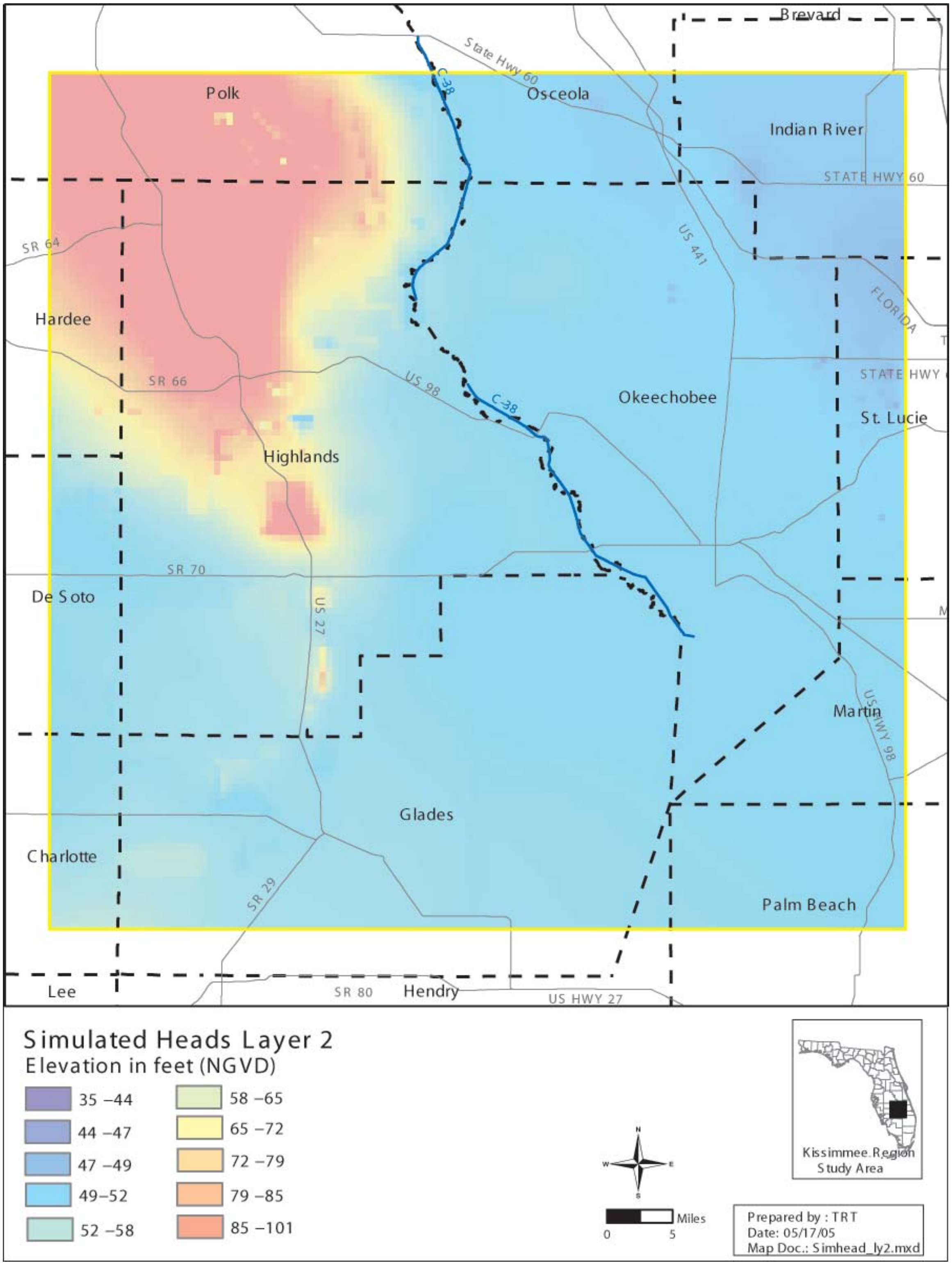

Figure 83. Simulated Heads Layer 2 - Elevations.

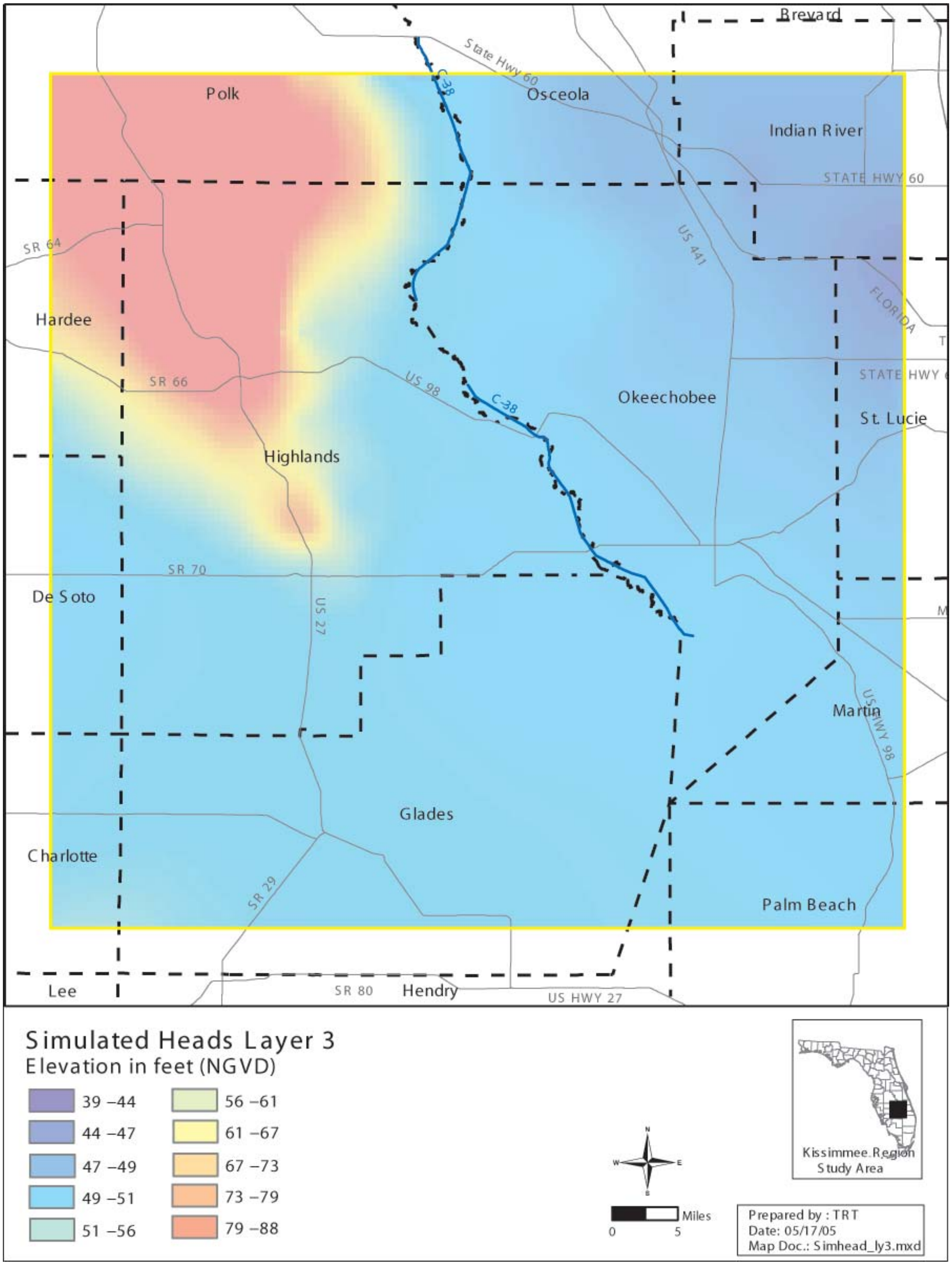

Figure 84. Simulated Heads Layer 3 - Elevations.

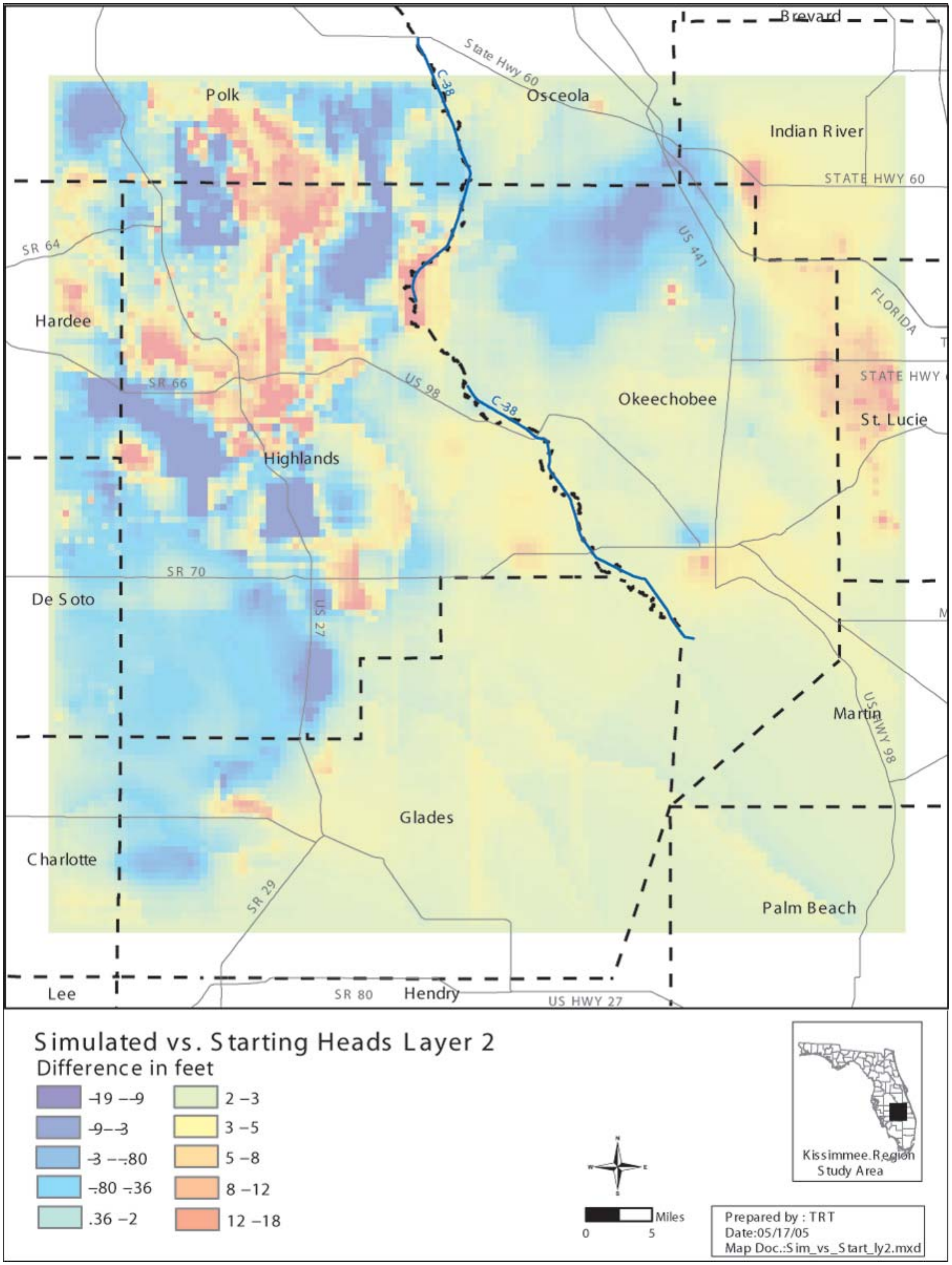

Figure 85. Simulated vs. Starting Heads Layer 2.

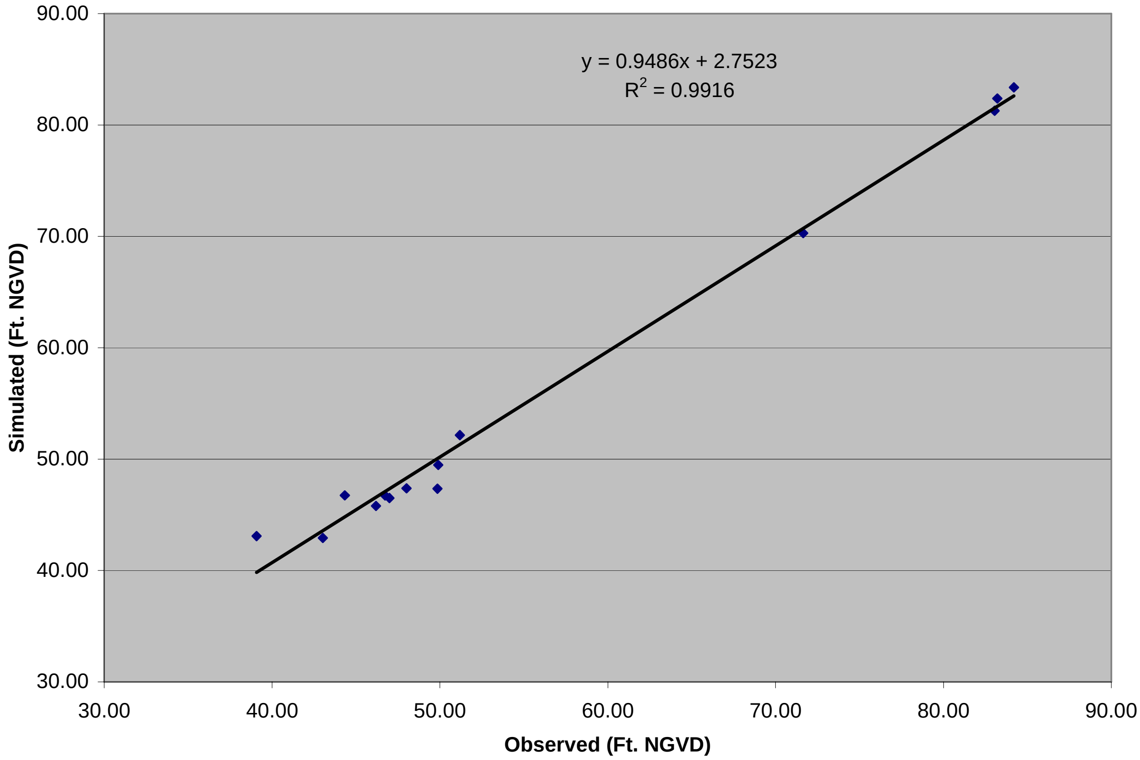

Figure 86. Observed Versus Simulated Layer 2 (Upper Floridan Aquifer) Water Levels, Average 1995 Conditions.

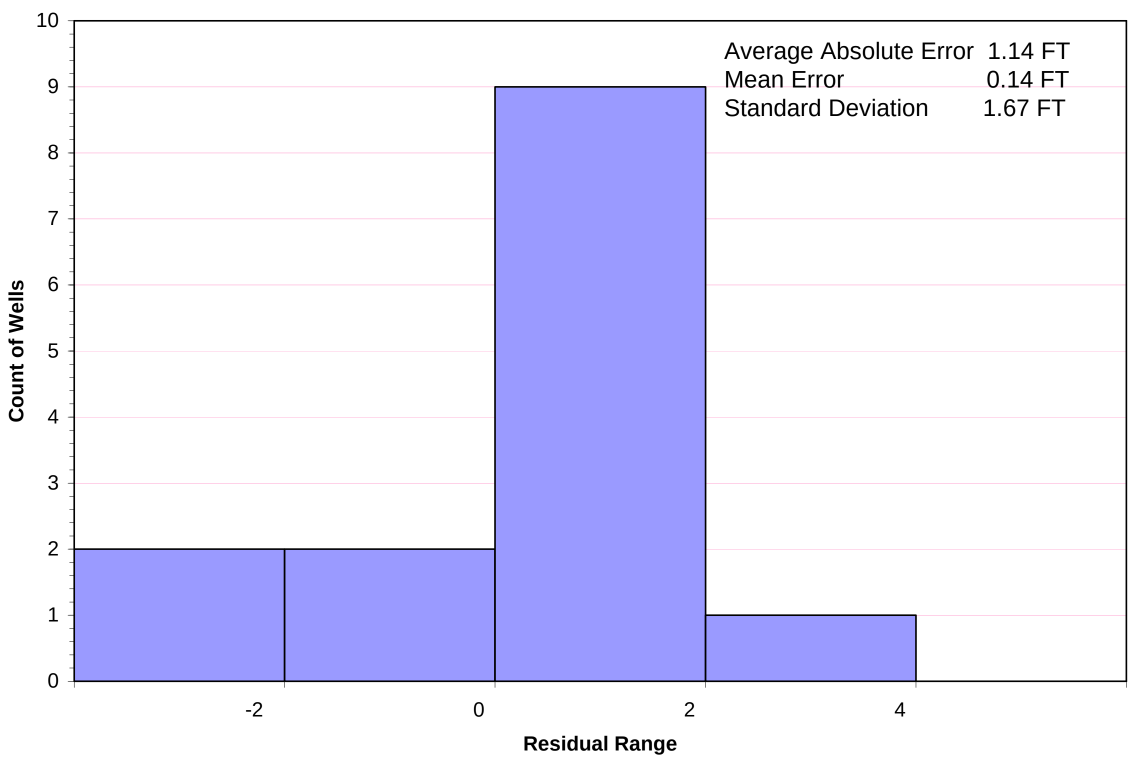

Figure 87. Layer 2 Water Level Residuals for 1995 Calibration.

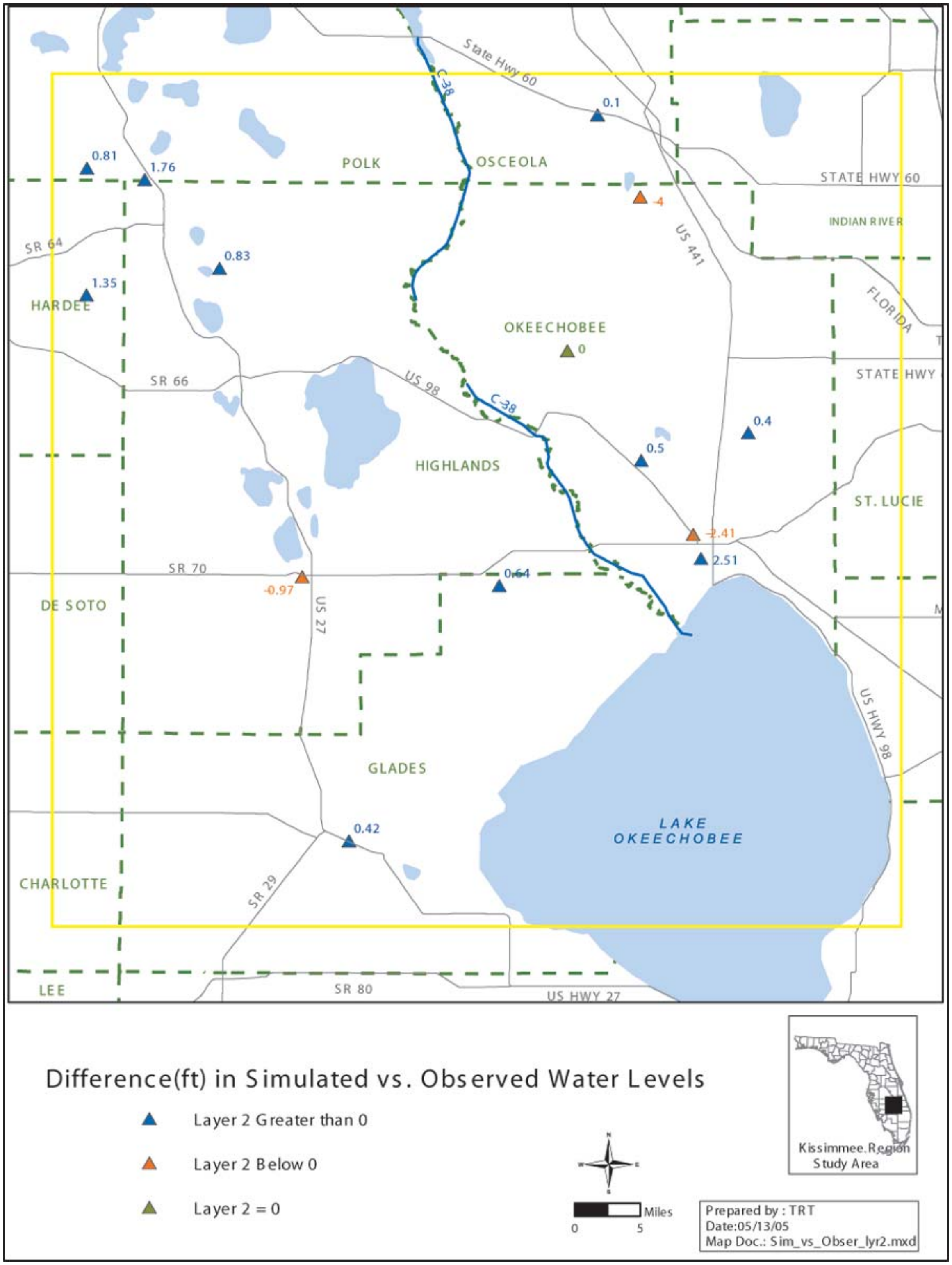

Figure 88. Layer 2 Water Level Residuals for 1995 Calibration (Map).

Table 19. Calibration Results Layer 3.

Station Name	Layer	Row	Col	Average 1995 Observed Water Level	Simulated Water Level	Difference in Water Levels	Met Calibration Criteria
S-65A(POF-20)WELL NR YEEHAW JUNCTION,FL	3	15	64	46.30	47.40	-1.10	True
73911801 33S30E06 USAF AVON PARK #1	3	16	38	77.79	75.35	2.44	True
SHEARER DEEP WELL NO 141 NEAR LEMON GROVE FL	3	25	10	78.10	78.36	-0.26	True
OKF-34	3	32	78	46.73	48.00	-1.27	True
HIF-3 73111501 HOWERTON'S WELL NR LORIDA,FL	3	33	49	53.85	54.67	-0.82	True
CITY SEBRING DEEP 24 AT SEBRING FL	3	37	26	83.49	82.10	1.39	True
HIF-32 GUILFORD TOMLINSON	3	39	42	53.62	54.46	-0.84	True
HIF-4 34S31E28 YUCAN RANCH NR LORIDA,FL	3	39	51	49.16	50.98	-1.82	True
HIF-13_G	3	48	55	47.53	48.50	-0.97	True
OKF-42	3	51	66	47.10	47.79	-0.69	True
FTB18	3	53	53	49.23	49.31	-0.08	True
FTB20	3	54	66	48.52	48.08	0.44	True
FTB17	3	57	62	49.80	48.65	1.15	True
HIF-16_G	3	58	14	61.92	56.80	5.12	
FTB19	3	65	72	48.92	48.17	0.75	True
HIF-14 P G PHYPERS	3	66	47	49.96	51.46	-1.50	True
ROMP 28 FLORIDAN WELL NR LAKE PLACID FL	3	69	39	70.13	68.37	1.76	True
FTB45	3	73	73	49.79	48.19	1.60	True
HIF-0037	3	75	57	47.16	47.34	-0.18	True
HIF-8 BOX RANCH	3	76	22	49.08	48.99	0.09	True
HIF-5 CHARLES STIDHAM	3	79	32	48.87	49.88	-1.01	True
HIF-23 GRAHAM CO DAIRY	3	91	16	48.68	48.49	0.19	True
HIF-26_G	3	92	38	49.19	49.59	-0.40	True
					Average Difference	1.50	
					Count Calibrated	22	
					% Calibrated	95.65%	

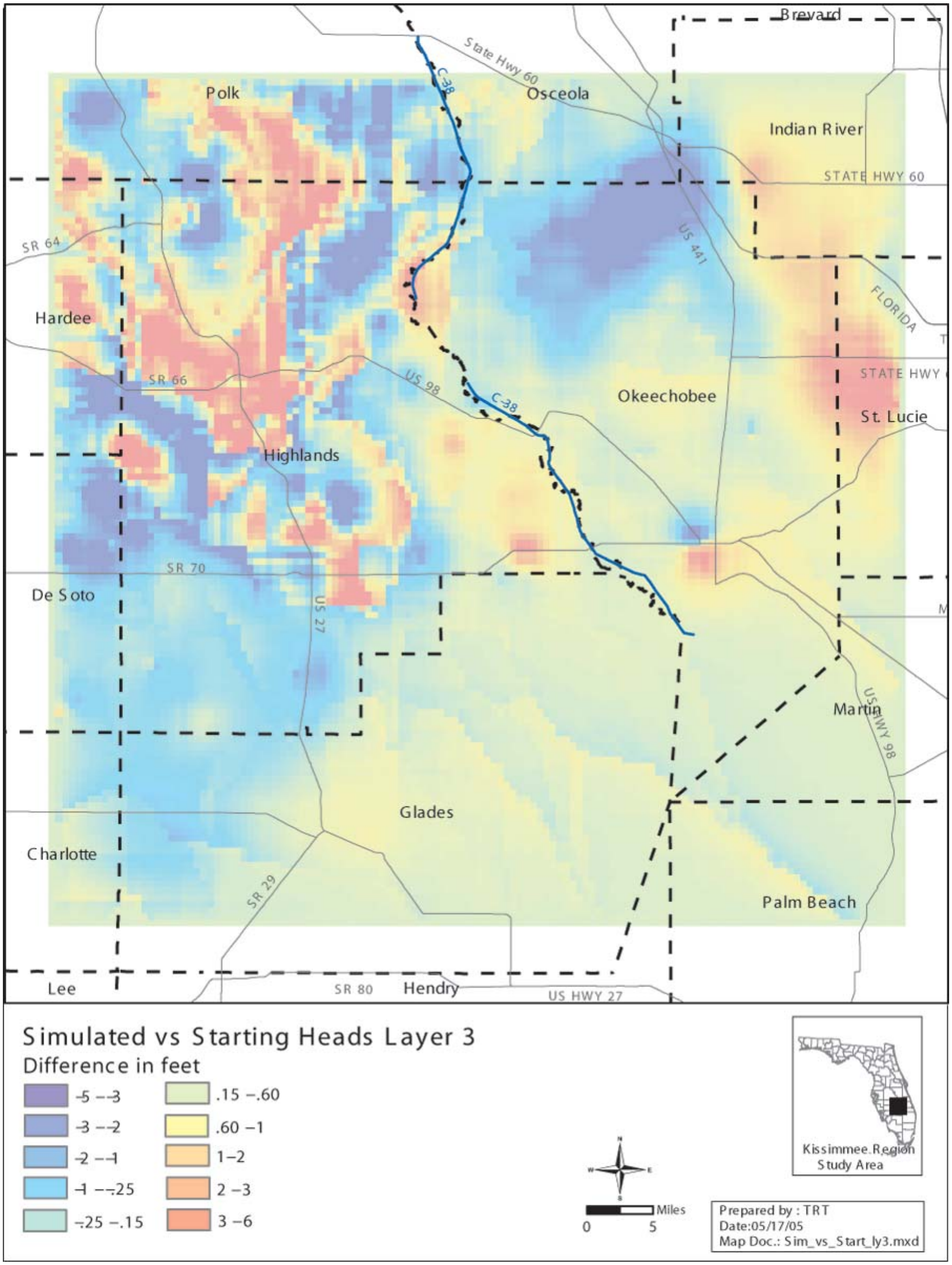

Figure 89. Simulated vs. Starting Heads Layer 3.

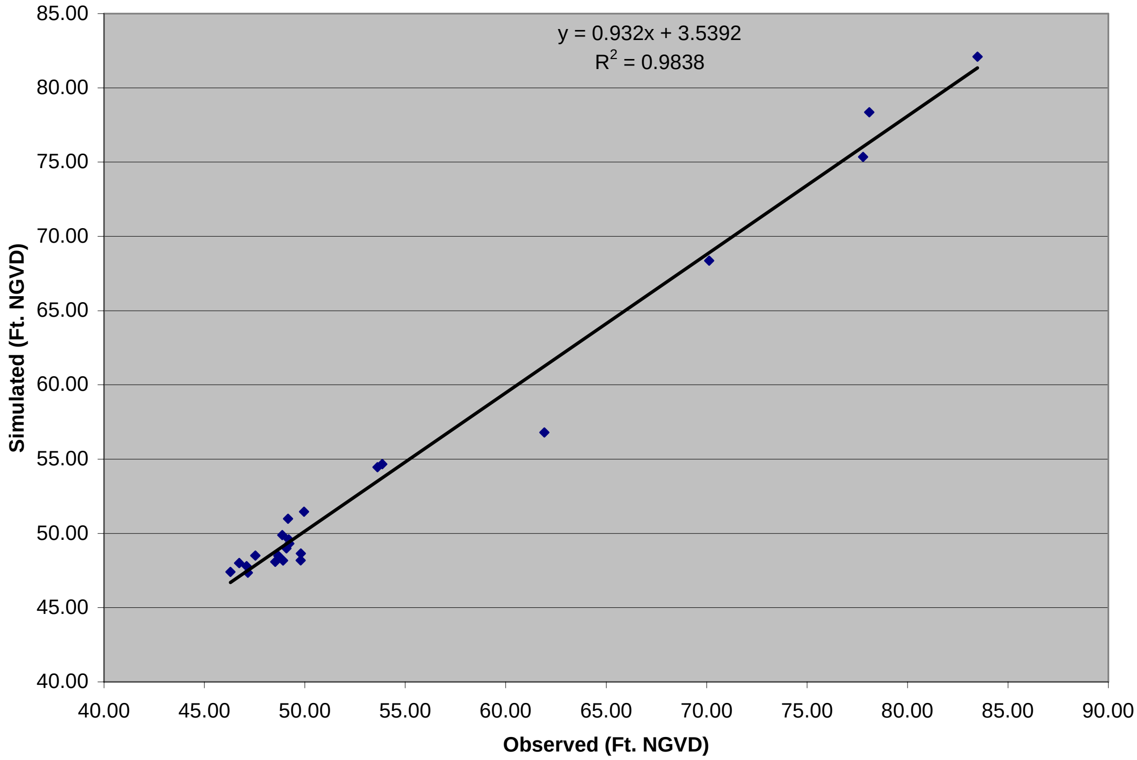

Figure 90. Observed Versus Simulated Layer 3 (Middle Floridan Aquifer) Water Levels, Average 1995 Conditions.

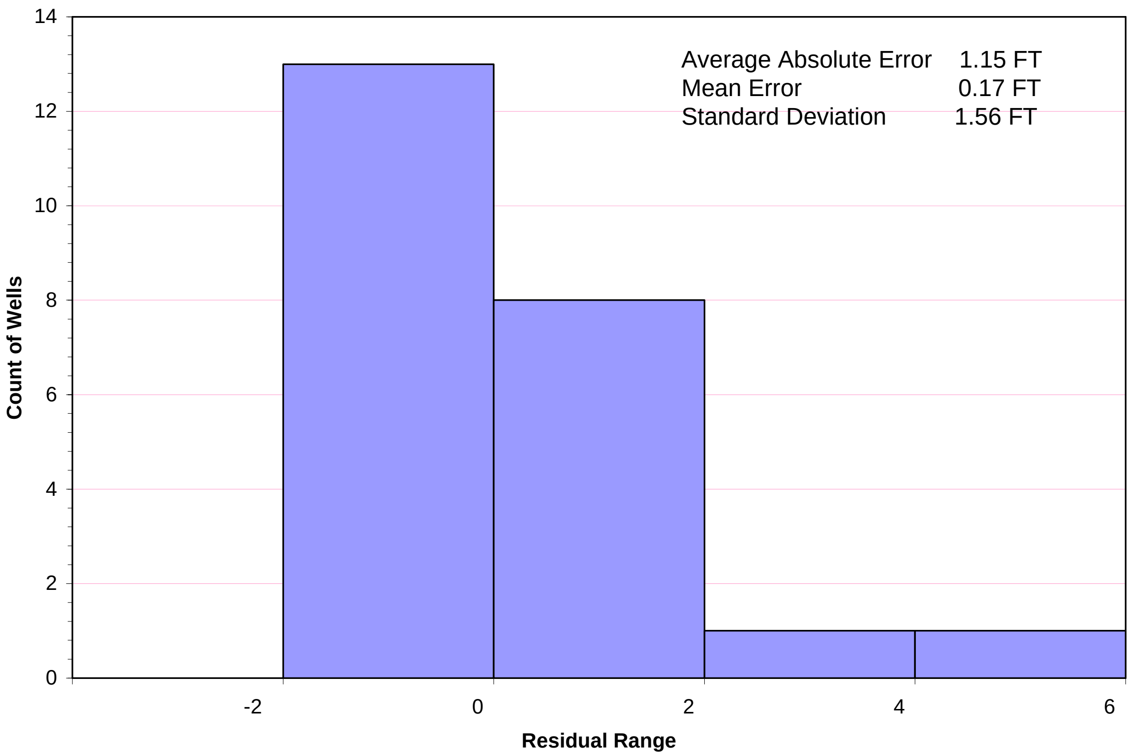

Figure 91. Layer 3 Water Level Residuals for 1995 Calibration.

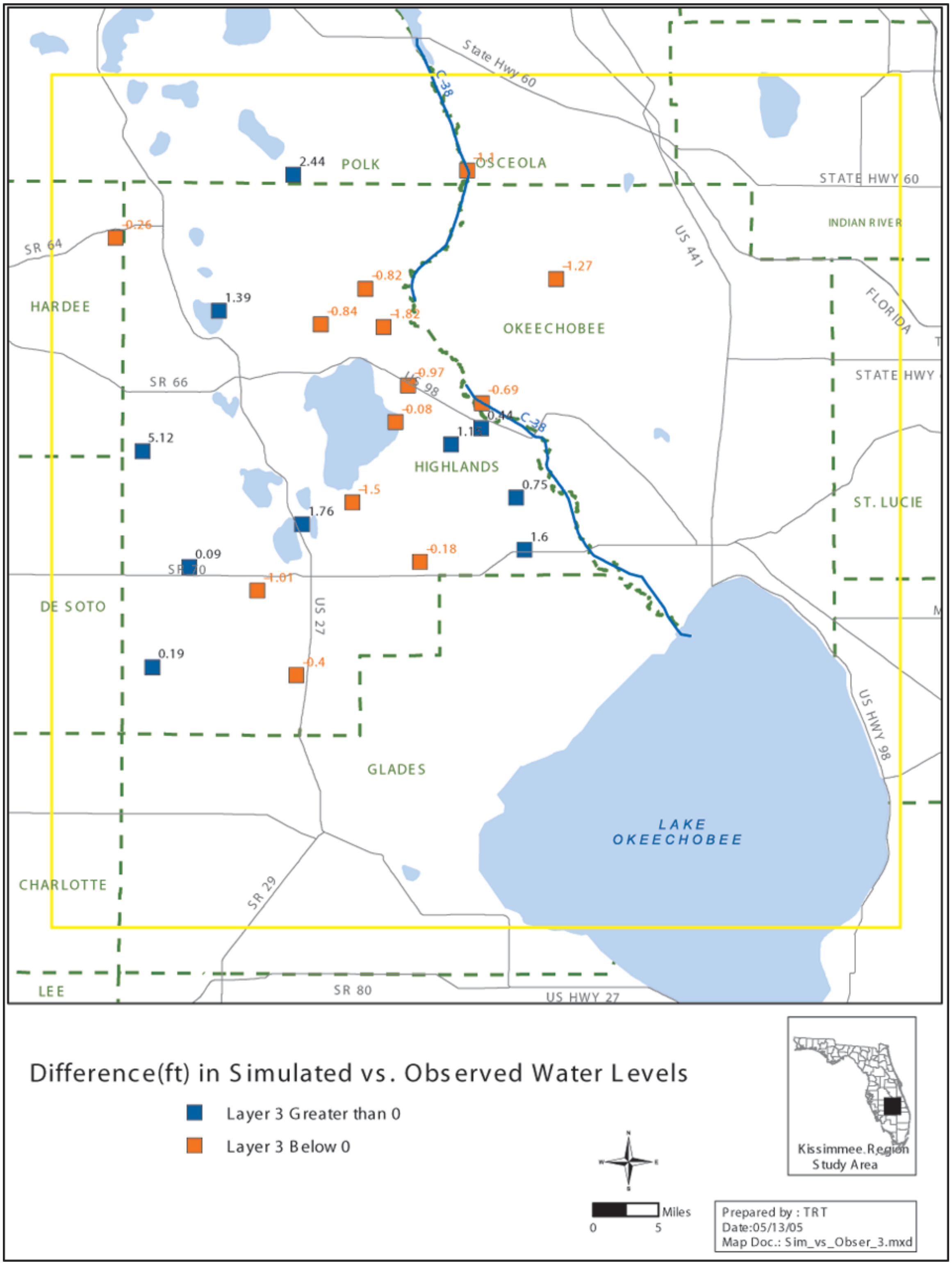

Figure 92. Layer 3 Water Level Residuals for 1995 Calibration (Map).

Some areas in St. Lucie, Martin and Indian River counties are in critical water supply problem areas (**Figure 93**). These areas must meet the special criteria outlined in (Chapter 40E-23, F.A.C). In areas where the water levels in the Floridan Aquifer System have a potentiometric head above land surface, there may be flowing wells (**Figure 94**). If a well flows at land surface, is required to have a valve pursuant to section 373.206, F.S. In addition, the Basis of Review 3.2.1D (SFWMD 2003) stipulates that flow in these flowing wells will be limited to flow, which is naturally emanated from the well. The model confirms that artesian condition exist in these areas.

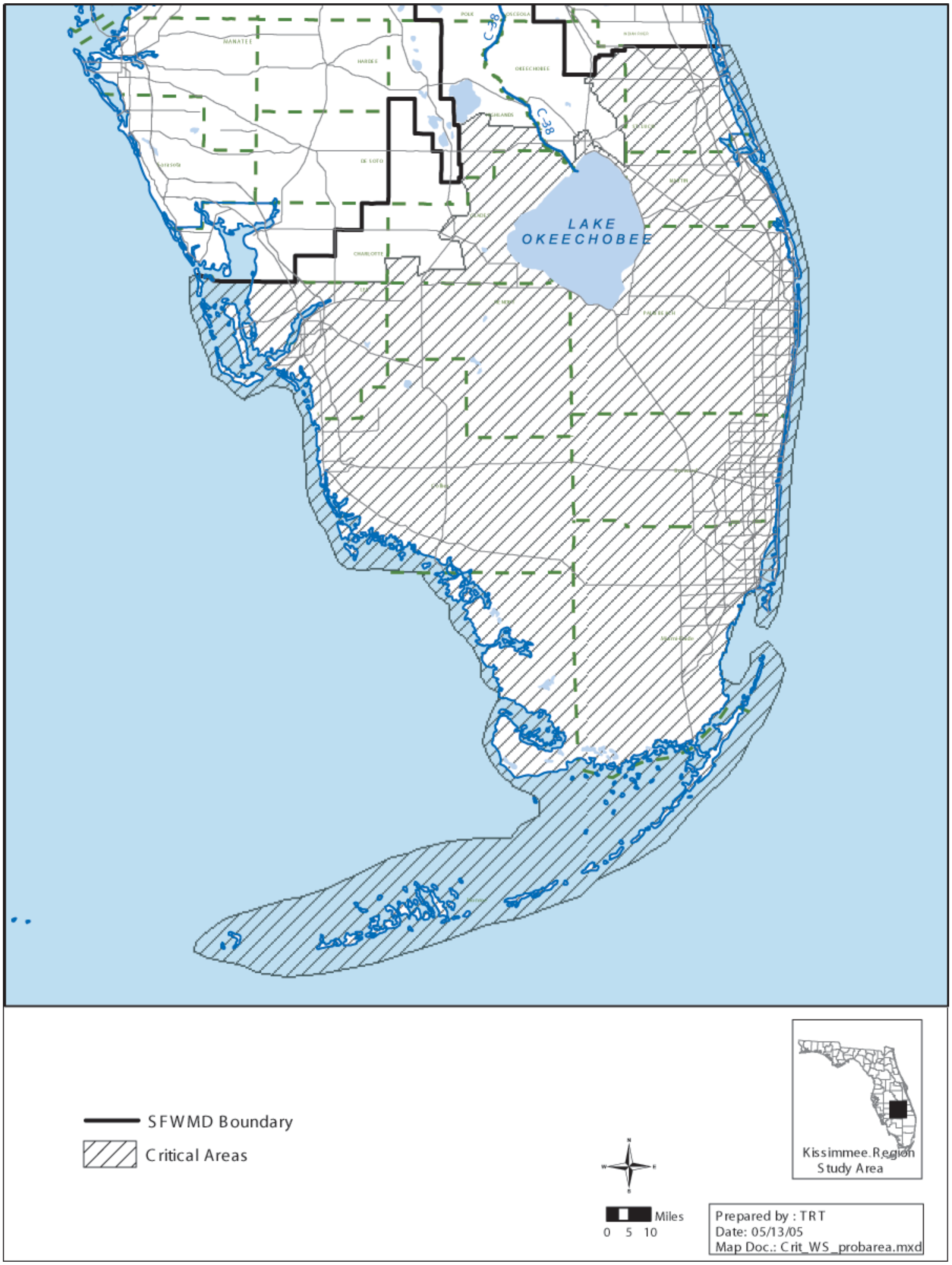

Figure 93. Critical Water Supply Problem Areas.

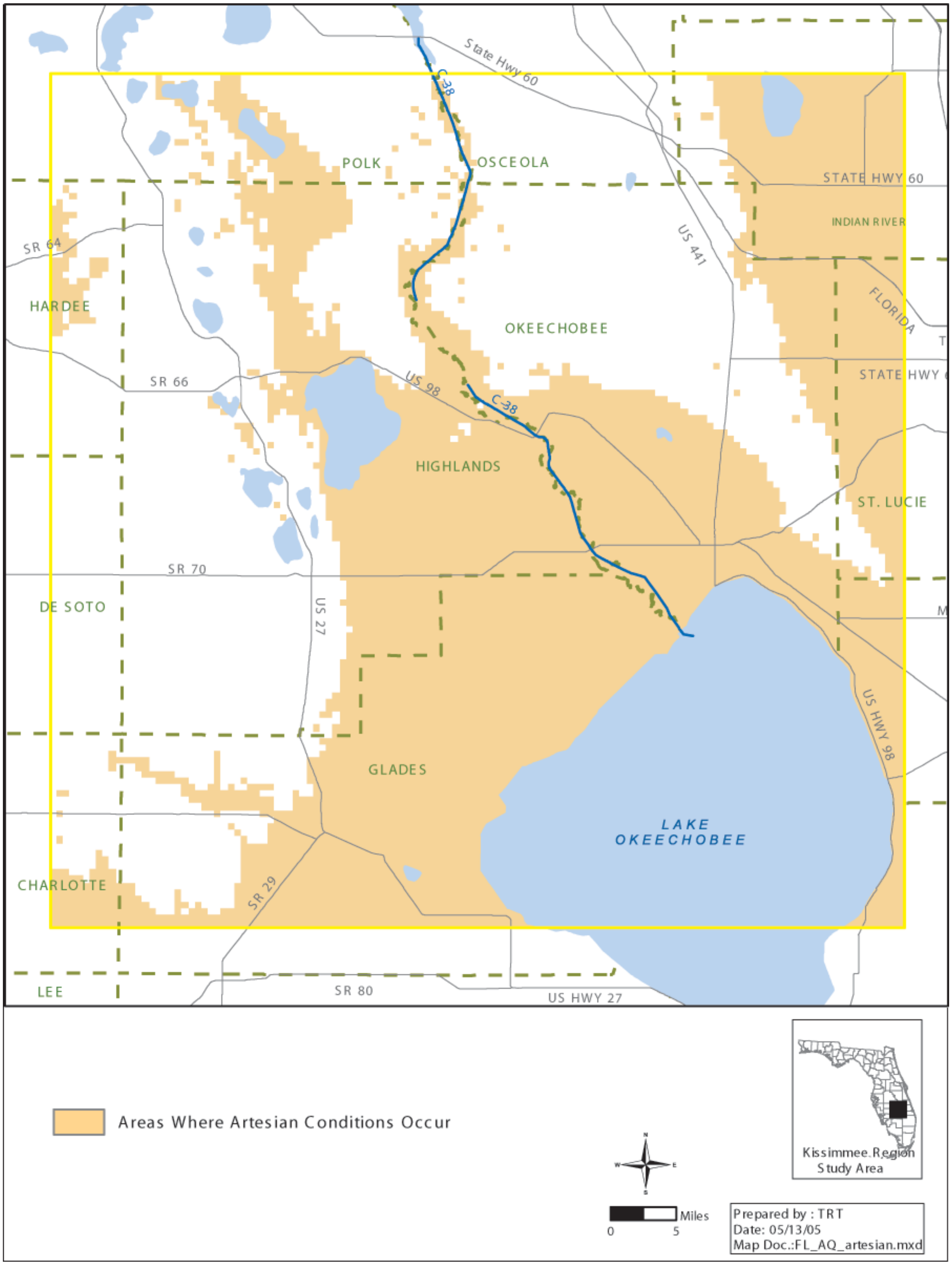

Figure 94. Areas Where the Floridan Aquifer is under Artesian Conditions.

The major source of water into Layer 1 is recharge. The major discharge of water from Layer 1 is evapotranspiration. Other water sources for the model are from rivers, while water discharges via drains, wells and constant heads. Layer 1 accounts for most of the volumetric water exchange in the model. Ninety-two percent of the water coming in to the model is coming in from Layer 1. Seventy-two percent of the water is leaving the model from Layer 1 via drains and evapotranspiration. The net vertical flow is downward with each successive layer receiving less water from the layer above. In 1995, wells represent only 4 percent of the overall volumetric budget. Most of the wells are in the Upper and Middle Floridan Aquifer and use 11 percent (**Table 20**), and 14 percent of the outflow in their respective layers. The simulated saturated evapotranspiration from the model is 13 inches/year this is equal to the total simulated saturated evapotranspiration volume divided by the model area. The mean maximum potential evapotranspiration is 22 inches/year. **Figure 95** shows the net flow cumulative volume by layer.

Table 20. Simulated Layer by Layer Volumetric Water Budgets for 1995 (in MGD).

Layer	Cumulative Volume (MGD)			% In	% Out
	Layer 1 In	Layer 1 Out	Layer 1 Net		
Constant Head	22.79	38.66	-15.87	0.39%	0.65%
Upper Boundary	0	0	0	0.00%	0.00%
Lower Boundary	148.60	561.66	-413.07	2.51%	9.49%
Wells	0	23.15	-23.15	0.00%	0.39%
Drains	0	1,838.30	-1,838.30	0.00%	31.06%
River Leakage	1,373.52	853.43	520.09	23.20%	14.42%
ET	0	2,603.08	-2,603.08	0.00%	43.98%
Recharge	4,374.53	0	4,374.53	73.90%	0.00%
TOTAL	5,919.44	5,918.28	1.15	100.00%	100.00%
Layer	**Layer 2 In**	**Layer 2 Out**	**Layer 2 Net**	**% In**	**% Out**
Constant Head	7.52	5.22	2.31	0.99%	0.68%
Upper Boundary	561.66	148.60	413.07	73.72%	19.48%
Lower Boundary	192.68	523.01	-330.33	25.29%	68.55%
Wells	0	86.18	-86.18	0.00%	11.29%
TOTAL	761.86	763.01	-1.13	100.00%	100.00%

Table 20. Simulated Layer by Layer Volumetric Water Budgets for 1995 (in MGD) (Continued).

Layer	Layer 3 In	Layer 3 Out	Layer 3 Net	% In	% Out
Constant Head	84.99	129.94	-44.94	8.78%	13.42%
Upper Boundary	523.01	192.68	330.33	54.04%	19.90%
Lower Boundary	359.81	506.80	-146.99	37.18%	52.34%
Wells	0	138.94	-138.94	0.00%	14.35%
TOTAL	967.81	968.36	-0.54	100.00%	100.00%
Layer	**Layer 4 In**	**Layer 4 Out**	**Layer 4 Net**	**% In**	**% Out**
Constant Head	364.59	510.14	-145.55	41.84%	58.64%
Upper Boundary	506.80	359.81	146.99	58.16%	41.36%
TOTAL	871.39	869.95	1.44	100.00%	100.00%
Layer	**All Layers In**	**All Layers Out**	**All Layers Net**	**% In**	**% Out**
Constant Head	479.9	683.96	-204.05	7.71%	10.98%
Wells	0	248.27	-248.27	0.00%	3.99%
Drains	0	1838.30	-1838.30	0.00%	29.52%
River Leakage	1373.52	853.43	520.09	22.05%	13.71%
ET	0	2603.08	-2603.08	0.00%	41.80%
Recharge	4374.53	0	4374.53	70.24%	0.00%
TOTAL	6227.95	6227.04	0.92	100.00%	100.00%

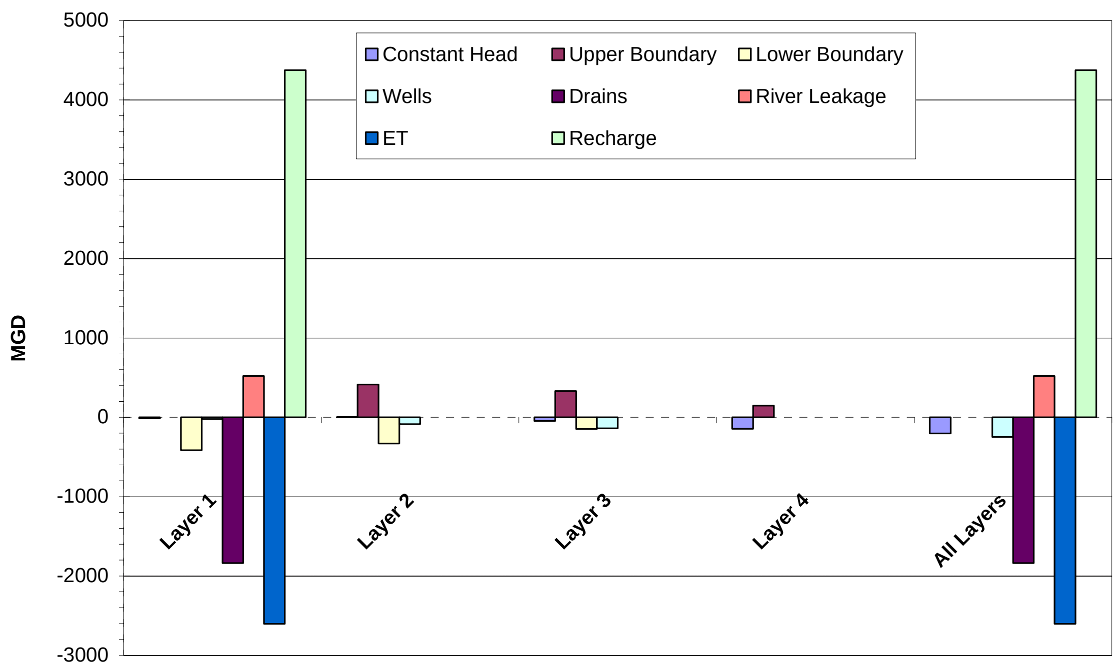

Figure 95. Net Flow - Cumulative Volume (MGD) by Layer.

The simulated vertical flows between Layers 1 and 2 (**Figure 96**) shows that the recharge areas are mainly in the western portion of the model, including Lake Wales Ridge and the area east of the Kissimmee River and west of the St. Johns Marsh, as well as the Allapattah Flats. The areas with artesian flow show upward flow from the Upper Floridan Aquifer into the Surficial Aquifer, but since the Intermediate Confining Unit is thick in those areas the volume of flow is much lower than in the recharge areas. The vertical gradient between Layers 2 and 3 (**Figure 97**) is similar to those mentioned between Layers 1 and 2, but there is a bit more flow through the Middle Confining Unit 1 than the Intermediate Confining Unit. The flow from Layer 3 to 4 (**Figure 98**), changes with some water flowing upward from the Lower Floridan Aquifer along the Lake Wales Ridge. There are no wells in the Lower Floridan Aquifer to prove this scenario, but this is consist with observations elsewhere in south Florida where the density equivalent heads in the Lower Floridan Aquifer are higher than those in the Middle and Upper Floridan Aquifer (Lukasiewicz 1999, 2001, Bennett 2003, Metz and Sacks 2002). The observation levels in Layers 2 and 3 were calibrated.

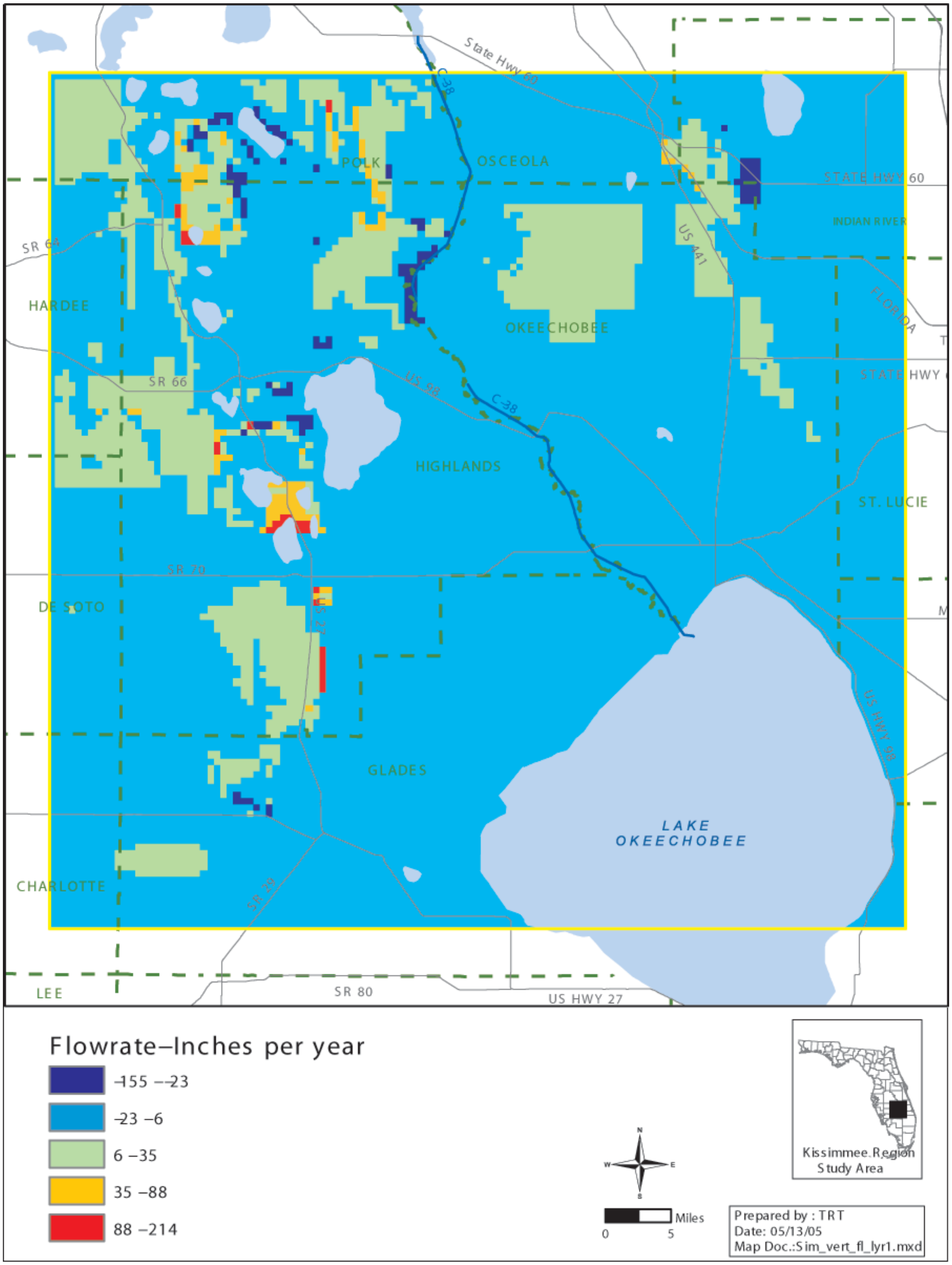

Figure 96. Simulated Vertical Flows between Layer 1 (Surficial Aquifer System) and Layer 2 (Upper Floridan Aquifer) for Average 1995 Conditions.

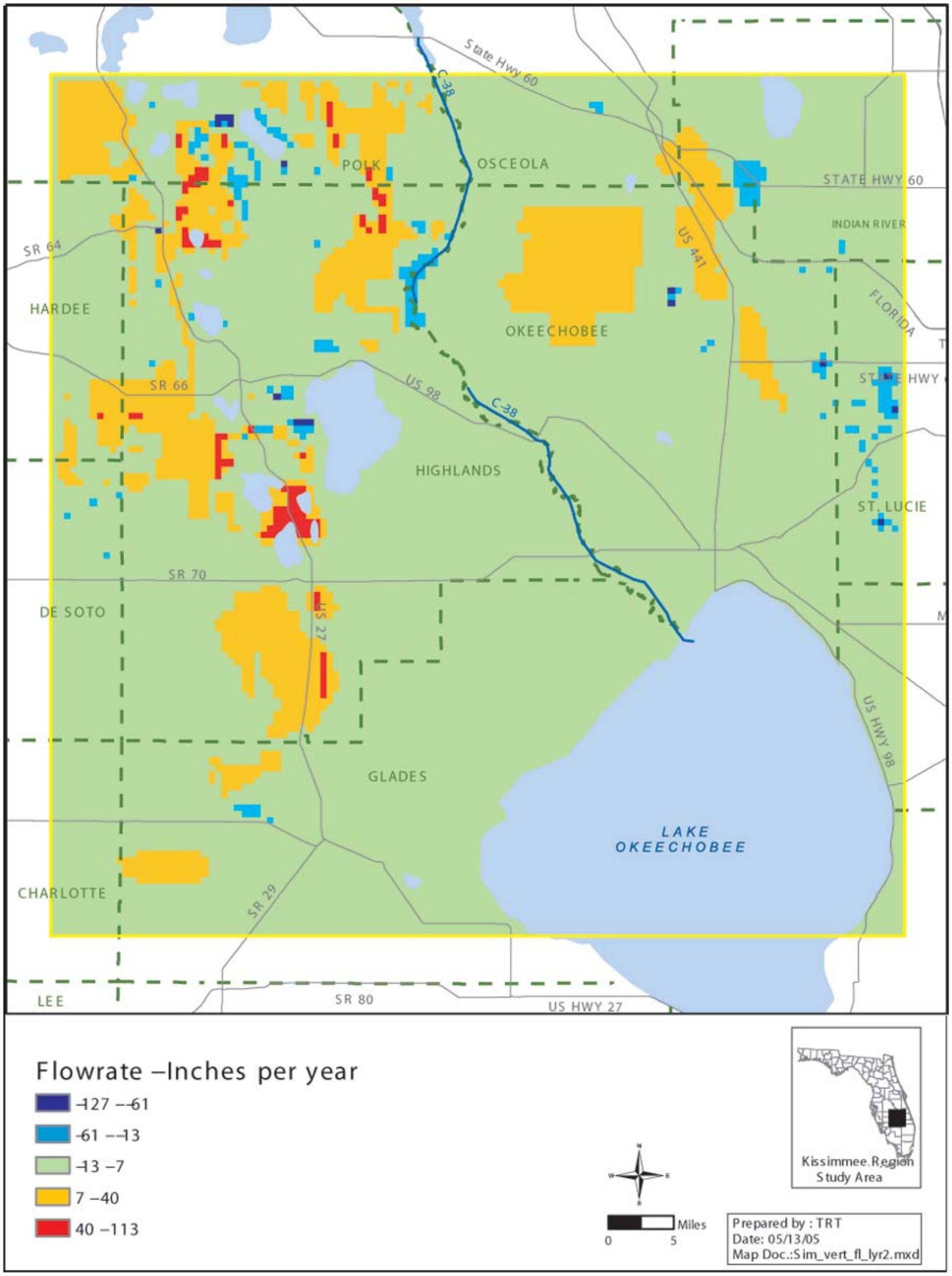

Figure 97. Simulated Vertical Flows between Layer 2 (Upper Floridan Aquifer) and Layer 3 (Middle Floridan Aquifer) for Average 1995 Conditions.

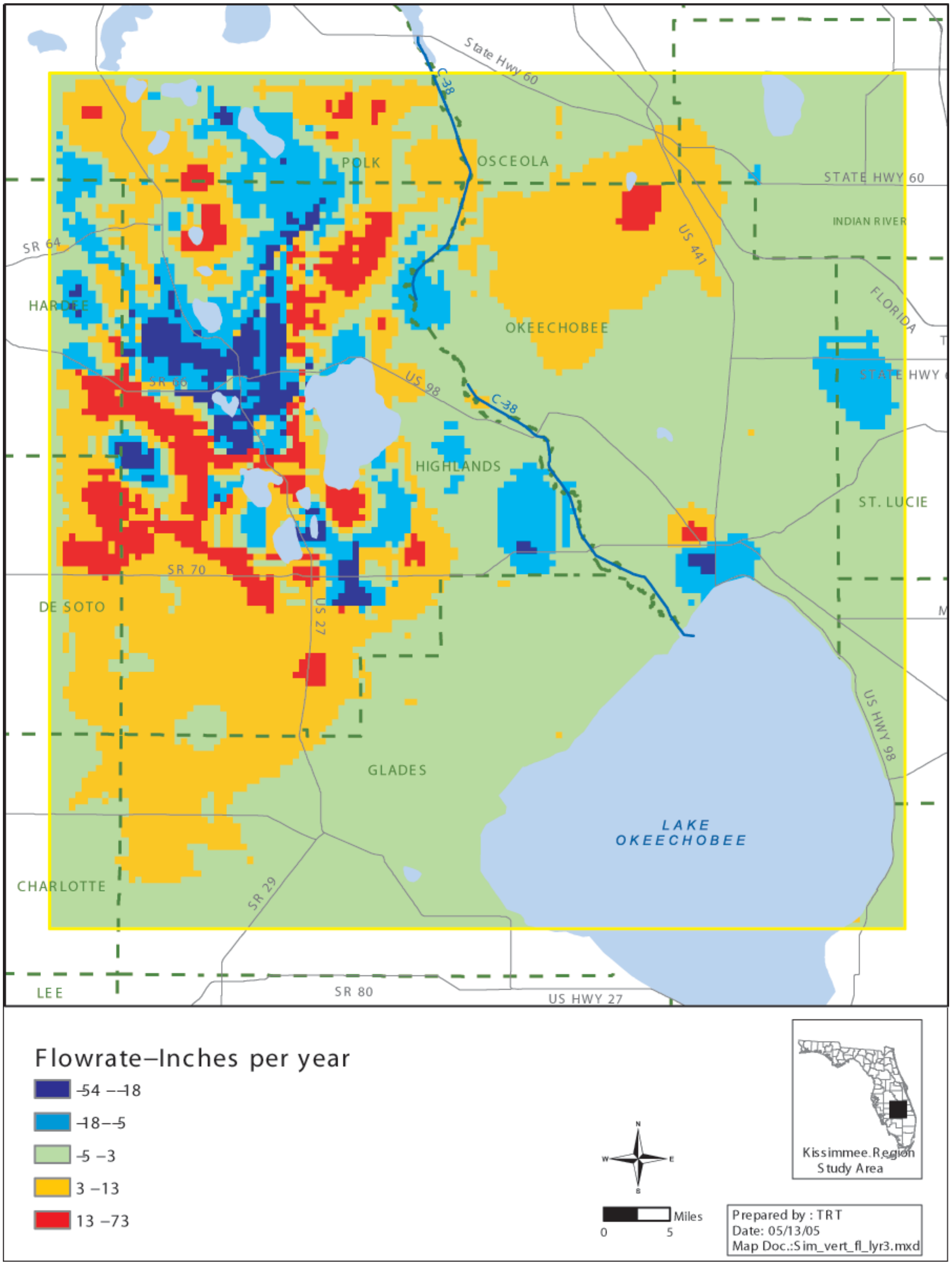

Figure 98. Simulated Vertical Flows between Layer 3 (Upper Floridan Aquifer) and Layer 4 (Middle Floridan Aquifer) for Average 1995 Conditions.

Sensitivity Analysis

The sensitivity analysis was conducted by changing one parameter at a time and assessing how it impacted all the layers (**Table 21**), how it impacted each layer individually and how it impacted the Upper and Middle Floridan aquifers combined (**Table 22**). **Table 22** assists is assessing which layer was influenced the most by each modification. When noted, the transmissivities for Layers 2 and 3 were both changed at the same time.

Layer 1 is sensitive to many parameters as it has more stresses applied to it. (ET Rate, Root Extinction Depth and ET Surface, Recharge and Rivers and Drains), which have little impact on the deeper aquifers. The vertical conductivity between the layers was most sensitive parameter for the Floridan Aquifer layers. The horizontal conductivity in Layer 1 and the transmissivities in the Floridan Aquifer layers were the next most sensitive parameters.

Table 21. Results of Sensitivity Analysis Lower Kissimmee Basin Groundwater Model (Composite for all Layers).

Parameter	Corresponding Change	Range of Head Difference			Notes
		Min	Max	Avg	
ET Rate	x 0.000028 (0.8 x calib)	-1.41	0.00	-0.06	
	x 0.000328 (1.2 x calib)	0.00	1.27	0.06	
ET Rate	x0.000301 (1.1 x calib rate)	0.00	0.65	0.03	
	x0.000246 (0.9 x calib rate)	-0.68	0.00	-0.03	
ET Surface	x 0.9	0.00	3.46	0.17	
	x 1.1	-2.63	0.00	-0.16	
ET Extinction Depth	x 2.0 (10 time original)	0.00	2.14	0.07	
	× 5.0 (25 times original)	0.00	4.30	0.18	
	× 0.1 (0.5 x original)	-2.16	0.00	-0.14	
Recharge	× 0.000456 (double rain in ft/day)	-12.53	0.00	-0.97	
	× 0.000114 (1/2 the rain in ft/day)	0.00	8.80	0.55	
Aquifer	**Corresponding Change**	**Range of Head Difference**			**Notes**
		Min	**Max**	**Avg**	
HK (Layer 1)	x 55	-892.08	19.12	-57.02	unrealistic head values in 800 - 900 ft range
	x 2.2	-46.94	0.00	-1.94	
	x 0.2				constant head cell went dry - simulation aborted

Table 21. Results of Sensitivity Analysis Lower Kissimmee Basin Groundwater Model (Composite for all Layers) (Continued).

Aquifer	Corresponding Change	Range of Head Difference			Notes
		Min	Max	Avg	
HK (Layer 1)	x0.5				constant head cell went dry - simulation aborted
	x0.9	-4.00	14.44	0.73	
	x 1.1	-3.91	0.00	-0.16	
Transmissivity (Layers 2, 3)	× 5.0	-2.93	7.00	0.01	
	× 0.5 (÷ 2)	-2.43	0.98	0.02	
	× 0.2 (÷ 5)	-4.59	2.15	0.05	
Transmissivity (Layers 2)	× 5.0	-1.03	0.39	-0.02	
	× 0.5 (÷ 2)	-0.05	0.20	0.01	
	× 0.2 (÷ 5)	-0.07	0.30	0.01	
Transmissivity (Layers 3)	× 5.0	-2.91	6.95	0.03	
	× 0.5 (÷ 2)	-2.36	0.96	0.01	
	× 0.2 (÷ 5)	-4.41	2.08	0.03	
VCONT (Layer 1_2)	× 10.0	-9.22	21.84	0.04	a few dry cells
	x1.1	-0.23	0.68	0.00	
	x 0.9	-0.68	0.23	0.00	
	× 0.1 (÷ 10)	-6.72	3.23	0.05	
VCONT (Layer 2_3)	x 0.9	-0.12	0.23	0.00	
	x1.1	-0.22	0.09	0.00	
	× 10.0	-4.31	0.92	-0.05	
	× 0.1 (÷ 10)	-6.57	3.45	-0.05	
VCONT (Layer 3_4)	x 0.9	-0.18	0.14	-0.01	
	x1.1	-0.11	0.17	0.01	
	× 10.0	-1.92	2.73	0.08	
	× 0.1 (÷ 10)	-4.07	4.18	-0.24	
River/Drain	**Corresponding Change**	**Range of Head Difference**			**Notes**
		Min	**Max**	**Avg**	
Conductance (both)	× 2.0	-13.73	2.76	-0.14	
	× 0.5 (÷ 2)	-4.51	14.18	0.37	one dry cell

Table 22. Results of Sensitivity Analysis Lower Kissimmee Basin Groundwater Model (by Layer).

	Layer 1			Layers 2 and 3			Layer 2			Layer 3		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
etrate x1.1	0.00	0.65	0.04	0.00	0.04	0.00	0.00	0.02	0.01	0.00	0.04	0.00
etrate x0.9	-0.68	0.00	-0.05	-0.04	0.00	0.00	-0.02	0.00	0.00	-0.04	0.00	0.00
etrate x0.8	-1.41	0.00	-0.10	-0.09	0.00	-0.01	-0.04	0.00	-0.01	-0.09	0.00	-0.01
etrate x1.2	0.00	1.27	0.08	0.00	0.07	0.01	0.00	0.03	0.01	0.00	0.07	0.01
etsurface x 10	-8.18	0.00	-0.55	-0.58	0.00	-0.06	-0.24	-0.01	-0.06	-0.58	0.00	-0.06
etsurface x 0.8	0.00	6.80	0.47	0.00	0.24	0.04	0.00	0.12	0.04	0.00	0.24	0.05
etsurface x 0.1	0.00	6.88	0.54	0.00	0.32	0.06	0.00	0.15	0.05	0.00	0.32	0.06
etsurface x 0.5	0.00	6.88	0.54	0.00	0.32	0.05	0.00	0.14	0.05	0.00	0.32	0.06
etsurface x 5	-8.18	0.00	-0.55	-0.58	0.00	-0.06	-0.24	-0.01	-0.06	-0.58	0.00	-0.06
etsurface x 2	-8.18	0.00	-0.55	-0.58	0.00	-0.06	-0.24	-0.01	-0.06	-0.58	0.00	-0.06
etsurface x 1.5	-6.34	0.00	-0.51	-0.58	0.00	-0.06	-0.24	-0.01	-0.06	-0.58	0.00	-0.06
etsurface x 1.1	-2.63	0.00	-0.24	-0.21	0.00	-0.03	-0.11	0.00	-0.03	-0.21	0.00	-0.03
etsurface x 0.9	0.00	3.46	0.25	0.00	0.13	0.03	0.00	0.11	0.03	0.00	0.13	0.03
exd x5 (25 x original)	0.00	4.30	0.27	0.00	0.16	0.02	0.00	0.07	0.02	0.00	0.16	0.03
exd x 0.1 (0.5 x original)	-2.16	0.00	-0.21	-0.07	0.00	-0.01	-0.07	0.00	-0.01	-0.07	0.00	-0.01
exd x 2 (10 x original)	0.00	2.14	0.11	0.00	0.06	0.01	0.00	0.03	0.01	0.00	0.06	0.01
rch x2	-12.53	0.00	-1.48	-1.09	0.00	-0.12	-0.40	-0.01	-0.12	-1.09	0.00	-0.13
rch x0.5	0.00	8.80	0.84	0.00	0.51	0.07	0.00	0.23	0.07	0.00	0.51	0.07
k l1 x 55	-892.08	19.12	-91.68	-15.09	0.00	-0.82	-15.09	0.00	-1.21	-4.25	0.00	-0.57
k l1 x 2.2	-46.94	0.00	-3.10	-0.04	0.00	0.00	-0.04	0.00	0.00	-0.03	0.00	0.00
k l1 x 0.9	-3.44	14.44	1.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
k l1 x 1.1	-3.91	0.00	-0.26	-0.01	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00
trans x 5 (Layers 2 & 3)	-0.28	0.34	0.00	-2.93	7.00	0.03	-1.15	1.96	0.05	-2.93	7.00	0.02
trans x 0.5 (Layers 2 & 3)	-0.10	0.15	0.00	-2.43	0.98	0.04	-0.83	0.70	0.06	-2.43	0.98	0.03
trans x 0.5 (Layers 2)	-0.04	0.06	0.00	-0.05	0.20	0.01	-0.05	0.20	0.02	-0.04	0.05	0.01
trans x 5 (Layers 2)	-0.21	0.13	0.00	-1.03	0.39	-0.06	-1.03	0.33	-0.14	-0.23	0.39	-0.01
trans x 0.5 (Layers 3)	-0.07	0.07	0.00	-2.36	0.96	0.03	-0.77	0.57	0.03	-2.36	0.96	0.03
trans x 5 (Layer 3)	-0.12	0.22	0.01	-2.91	6.95	0.07	-1.03	1.84	0.14	-2.91	6.95	0.03
trans x 0.2 (Layers 2 & 3)	-0.19	0.37	0.00	-4.59	2.15	0.12	-1.71	1.70	0.16	-4.59	2.15	0.10
trans x 0.2 (Layers 2)	-0.06	0.11	0.00	-0.07	0.30	0.02	-0.07	0.30	0.03	-0.06	0.08	0.01
trans x 0.2 (Layers 3)	-0.13	0.16	0.00	-4.41	2.08	0.08	-1.58	1.30	0.08	-4.41	2.08	0.08
vcont 1_2 x 10	-3.61	21.84	0.48	-9.22	2.67	-0.71	-9.22	1.29	-1.13	-3.12	2.67	-0.45
vcont 1_2 x 01	-6.72	1.98	-0.14	-0.76	3.23	0.36	-0.14	2.31	0.38	-0.76	3.23	0.35
vcont2_3x 01	-1.37	0.65	-0.04	-6.57	3.45	-0.07	-6.57	2.09	-0.55	-0.40	3.45	0.21
vcont2_3x 10	-0.29	0.31	0.00	-4.31	0.92	-0.13	-0.82	0.92	-0.03	-4.31	0.31	-0.19
vcont3_4x 10	-0.10	0.26	0.01	-1.92	2.73	0.19	-1.07	2.73	0.15	-1.92	1.79	0.22
vcont3_4x 0.1	-0.23	0.02	-0.02	-4.07	4.18	-0.61	-4.07	1.09	-0.50	-3.39	4.18	-0.68
vcont3_4x 0.9	-0.02	0.00	0.00	-0.18	0.14	-0.02	-0.18	0.04	-0.02	-0.12	0.14	-0.02
vcont1_2x 0.9	-0.68	0.17	-0.01	-0.06	0.23	0.03	-0.02	0.23	0.03	-0.06	0.16	0.02
vcont2_3x 0.9	-0.03	0.03	0.00	-0.12	0.23	0.01	-0.12	0.08	0.00	-0.01	0.23	0.01
vcont12x1.1	-0.16	0.68	0.01	-0.23	0.07	-0.03	-0.23	0.01	-0.03	-0.14	0.07	-0.02
vcont23x1.1	-0.02	0.02	0.00	-0.22	0.09	-0.01	-0.06	0.09	0.00	-0.22	0.02	-0.01
vcont34x1.1	0.00	0.01	0.00	-0.11	0.17	0.02	-0.04	0.17	0.01	-0.11	0.10	0.02
rivdarinx2	-13.73	2.76	-0.23	-0.13	0.06	0.00	-0.13	0.03	-0.01	-0.08	0.06	0.00
rivdrnx0.5	-4.51	14.18	0.57	-0.09	0.46	0.03	-0.05	0.14	0.01	-0.09	0.46	0.05

Model Verification

A model verification run was conducted for the year 2004. The only changes to model datasets were river, evapotranspiration, recharge, agricultural well and public water supply file modifications.

River

Stage data were collected for all the structures in the model area (from DBHYDRO) and the average 2004 values were applied to those cells in the model. Lake and river stages were collected from the SFWMD DBHYDRO database, the SWFWMD database and the USGS National Water Information System database. When stage data for lakes or rivers were unavailable for 2004 and for stream data where the stages were estimated from topography, the 1995 data were used.

Evapotranspiration, Recharge and Irrigation Demands

Not all of the rain stations used for the 1995 calibration were still monitoring data in 2004. When a station was not available, data from the nearest station were assigned to that rain station. Some sites had more than one monitoring device. Data from 61 devices (DBKeys) were used in 1995, 37 of these were available in 1995.

The year 2004 was drier than 1995. In 2004, the average annual rainfall for the stations in the model area was 43 inches vs. 53 inches of rain in 1995.

In the late 1990s, the SFWMD began installing weather stations. The potential evapotranspiration for these stations was calculated. The potential reference evapotranspiration was calculated by the "South Florida Water Management District Simple Method" using *wet marsh reference evapotranspiration*, as described in Irizarry-Ortiz (2003), these values are stored in DBHYDRO. The weather stations, which had potential evapotranspiration data calculated for 2004 were S65CW, S65DWX, S78W, CFSW and Belle Glade. The data from these stations were assigned to the nearest evapotranspiration Thiessen polygon used for the 1995 calibration run.

Estimates of agricultural demands were modified from the 1995 calibration run. Recharge, evapotranspiration and irrigation time series demands were computed using the ET-Recharge Model (Restrepo and Giddings 1994). This is an extension of the Agricultural Field-Scale Irrigation Requirements Simulation (AFSIRS) Program, which estimates irrigation demands on a daily basis for a specific crop and acreage due to soil, rainfall, evapotranspiration and other parameters (Smajstrla, 1990).

The agriculture well file was derived from the land use. Irrigation demands for each cell were determined by combining the GIS coverages for the land use, permitted areas, soil coverage, evapotranspiration and rainfall stations. The irrigation demand was then calculated for each individual polygon, and composite irrigation for each cell of the model is ultimately developed. This approach tends to result in a more accurate, seasonal representation of the irrigation demands, but the overall annual demand is not significantly different than that calculated using the Blaney-Criddle Method, which was used in the original 1995 calibration. For the 1995 calibration run, the agriculture well file was based on the consumptive use permits, which calculate irrigation demands based on the Blaney-Criddle Method. The water levels for each model layer from the AFSIRS run were compared to the water levels that were achieved in the 1995 calibration run using permitted values.

The total 1995 agriculture water use estimated from the permits was 248 MGD while 200 MGD was estimated with AFSIRS based on land use.

For 2004, the irrigation requirements for the agriculture wells were based on the 2000 land use. The total agriculture water use estimated from AFSIRS was 410 MGD.

The year 2004 was drier than 1995. In 2004, the average annual rainfall for the stations in the model area was 43 inches vs. 53 inches of rain in 1995.

Only 51 of the 99 observation sites used for the model calibration (1995) had usable data for 2004 (see **Table 23** for observation sites, see **Appendix E** for observation data). To supplement these observation sites, data were collected for sites that were added since 1995, and older sites that were missing observation points in 1995. A total of 112 observation sites were used for the verification run (see **Figure 99** for locations). Eighty-nine of the sites are in Layer 1, 13 in Layer 2 and 10 in Layer 3.

Of the 51 observation sites used in both the calibration and verification runs, 24 calibrated better than the calibration run. Fifty of the common sites met calibration criteria. **Figure 100** shows the trend lines for these observation sites and **Figure 101** shows the trend line for all the sites used in 2004. The trend line for 2004 falls on the same line as the 1995 permitted agriculture line. The permits assume 1-in-10 conditions when applications for water use are made. The 2004 rain conditions were close to a 1-in-10 year, thus the trend lines were similar.

Of the 89 wells and stage sites in Layer 1, 82 met the calibration criteria of ±4 (See **Table 24**; see **Figure 102** for trend line). Six wells did not meet the criteria, one of those is on Avon Park Ridge, which as explained in the calibration section, is difficult to calibrate, due to the steep topographical changes and limited information on the streams.

The other stations are near canals, which are input to the model as river cells. The modeled water levels in Layer 1 cells tend to be close to the input stages. When groundwater wells are further from the river cell, the water levels in the wells differ more from the river stages. **Figure 102** shows the trend line for Layer 1 sites.

There are thirteen observation wells in Layer 2 (Upper Floridan Aquifer), ten of these calibrated (See **Table 25**; see **Figure 103** for trend line). KRENND was simulated at 47 feet, while the average observation for that site was 50.62. The highest water level observed at this site since installation in 1997, was 53.86 feet in September, 2004. The lowest was 47.35 feet in June of 2000.

Lake Placid Grove well only had one reading for 2004. In other years, the water levels in this well fluctuated throughout the year by as much as 5 feet.

For Well GL267, near Palmdale, the model simulated water levels that were too high by over 8 feet. This well is 600 feet deep and is located below the Fisheating Creek flood plane. The creek may be supplying too much water to Layer 1, which is recharging into Layer 2.

There are ten observation sites in Layer 3 – the Middle Floridan Aquifer, nine of these calibrated (**Table 26**; See **Figure 104** for trend line). One well did not calibrate near S65A (POF20).

The verification run shows that in most areas the model accurately represented the observed water levels.

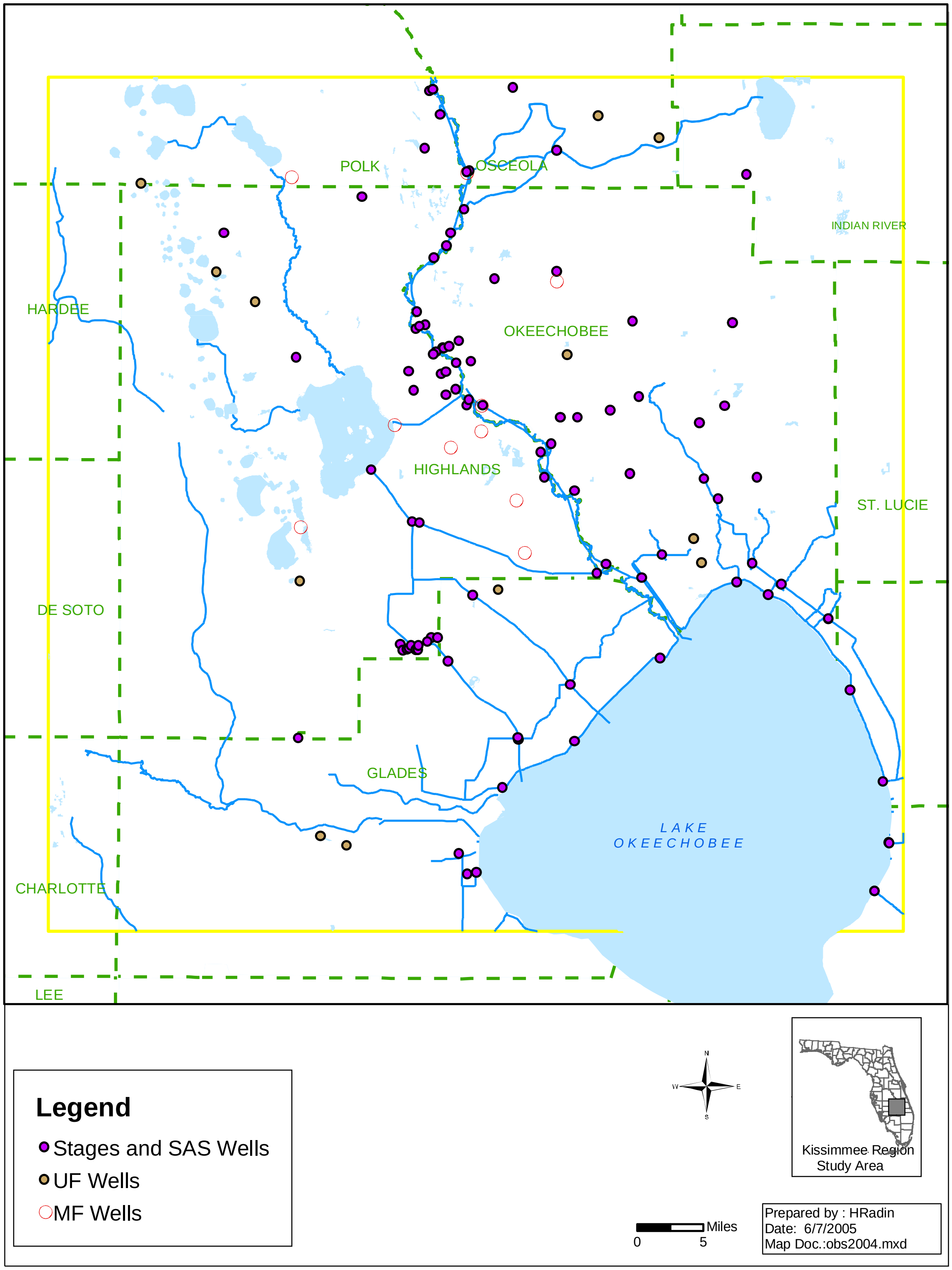

Figure 99. 2004 Observation Sites.

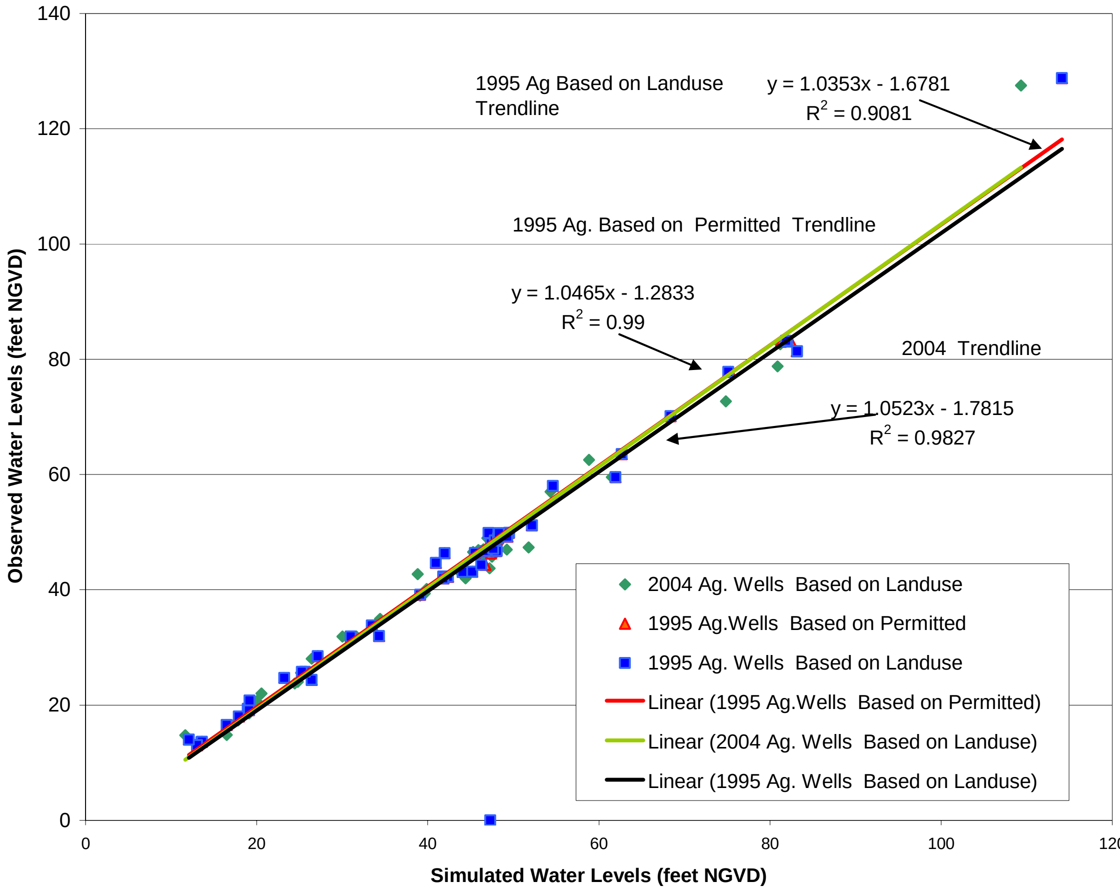

Figure 100. Observed vs. Simulated Water Levels in Observation Sites used for Calibration in 2004.

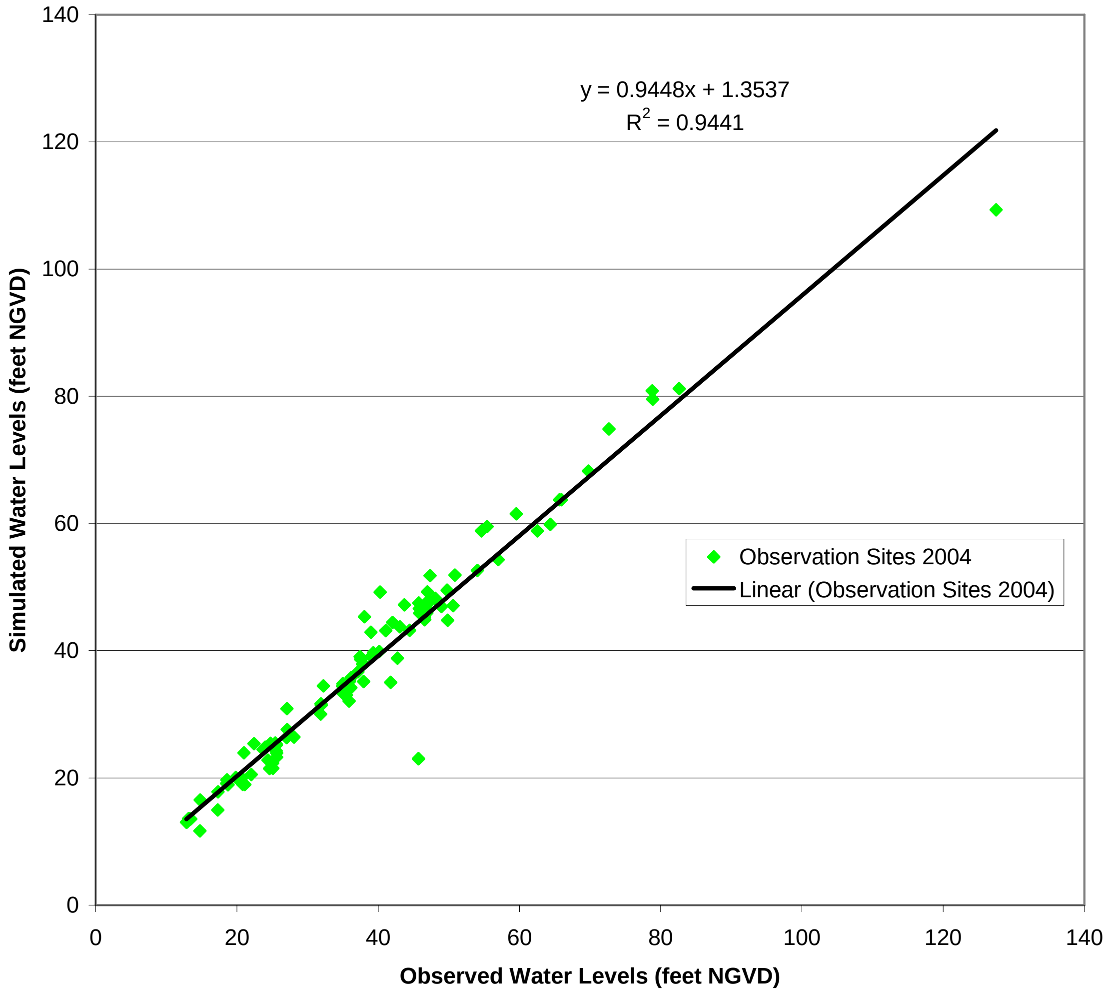

Figure 101. Observed vs. Simulated Water Levels in Observation Sites (2004 Conditions).

Table 23. Observation Sites 2004 vs. Observation Sites 1995.

Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Average Diff.	Average Observed Water Levels 1995	Simulated Water Levels 1995	Average Diff.
MAXCEY N_G	62.54	58.84	3.70	63.56	62.69	0.87
S65AX_H	47.00	46.51	0.49	46.33	41.98	4.35
S65A_H	46.55	45.29	1.26	46.40	45.51	0.89
IR-25_G	28.06	26.42	1.64	28.48	27.13	1.35
AVON P_G	127.51	109.34	18.17	128.78	114.14	14.64
C38.PINE	43.08	43.74	-0.66	43.08	44.08	-1.00
FTKISS	40.15	39.87	0.28	42.31	41.81	0.50
WEIR3_H	39.34	39.65	-0.31	42.24	42.37	-0.13
WEIR2_H	39.38	39.37	0.01	41.95	41.84	0.11
OK-3_G	59.56	61.53	-1.97	59.53	61.94	-2.41
BASSETT_G	42.02	44.42	-2.40	43.14	45.20	-2.06
S65C_H	34.97	34.42	0.55	33.81	33.48	0.33
OK-2_G	42.72	38.82	3.90	44.67	40.96	3.71
S68_H	39.01	39.12	-0.11	39.12	39.12	0
YATES M_H	23.72	24.45	-0.73	24.37	26.44	-2.07
S82_H	31.88	30.03	1.85	31.87	30.99	0.88
S83_H	31.89	31.66	0.23	31.97	34.31	-2.34
S84_H	24.04	24.83	-0.79	24.71	23.22	1.49
S154_H	22.02	20.55	1.47	20.28	19.19	1.09
S133_H	13.24	13.57	-0.33	13.57	13.57	0
NUBBC_H	18.73	18.90	-0.17	19.36	18.98	0.38
S75_H	25.57	25.31	0.26	25.78	25.64	0.14
S191_H	18.54	19.12	-0.58	19.12	19.12	0
S70_H	25.60	25.18	0.42	25.76	25.30	0.46
S127_H	13.46	13.56	-0.10	13.56	13.56	0
S72_H	20.68	20.00	0.68	20.77	19.18	1.59
S135_H	13.14	13.60	-0.46	13.60	13.60	0
H-15A_G	57.00	54.33	2.67	58.04	54.62	3.42
S129_H	12.97	13.06	-0.09	13.06	13.06	0
S131_H	12.87	13.04	-0.17	13.04	13.04	0
NIOC3	17.33	17.83	-0.50	17.99	17.92	0.07
NICO1	14.75	11.67	3.08	13.99	12.07	1.92
CULV5A_H	14.80	16.52	-1.72	16.52	16.52	0
CLENNY DEEP NW/O AVON PK FL	82.61	81.19	1.42	83.05	81.29	1.76
BONNET LAKE DEEP NEAR SEBRING FL	78.78	80.88	-2.10	83.21	82.38	0.83

Table 23. Observation Sites 2004 vs. Observation Sites 1995 (Continued).

Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Average Diff.	Average Observed Water Levels 1995	Simulated Water Levels 1995	Average Diff.
727100-- 35S33E02 BASS WELL N OF BASSINGER (okf18)	45.82	46.59	-0.77	46.73	46.73	0
OKF-23	46.88	45.91	0.97	44.34	46.75	-2.41
OKF-31_G	48.95	47.96	1.99	49.85	47.34	2.51
LAKE PLACID GROVES DEEP SOUTH OF LAKE PLACID FL	47.36	51.80	-4.44	51.19	52.16	-0.97
71110501OBSER WELL GL155 NEAR BRIGHTON, FL.	46.88	47.20	-0.32	48.01	47.37	0.64
65411601 41S30E12 CLEMONS PALMDALE	49.75	49.50	0.25	49.90	49.51	0.39
S-65A(POF-20)WELL NR YEEHAW JUNCTION,FL	43.74	47.22	-3.48	46.30	47.40	-1.10
73911801 33S30E06 USAF AVON PARK #1	72.69	74.84	-2.15	77.79	75.40	2.39
OKF-34	45.76	47.52	-1.76	46.73	48.00	-1.27
OKF-42	46.94	47.78	-0.54	47.10	47.79	-0.69
FTB18	46.99	49.24	-2.25	49.23	49.31	-0.08
FTB20	46.79	47.49	-0.70	48.52	48.08	0.44
FTB17	47.19	47.78	-0.59	49.80	48.65	1.15
FTB19	48.15	48.03	0.12	48.92	48.17	0.75
ROMP 28 FLORIDAN WELL NR LAKE PLACID FL	69.76	68.25	1.51	70.13	68.39	1.74
FTB45	48.09	48.25	-0.16	49.79	48.19	1.60

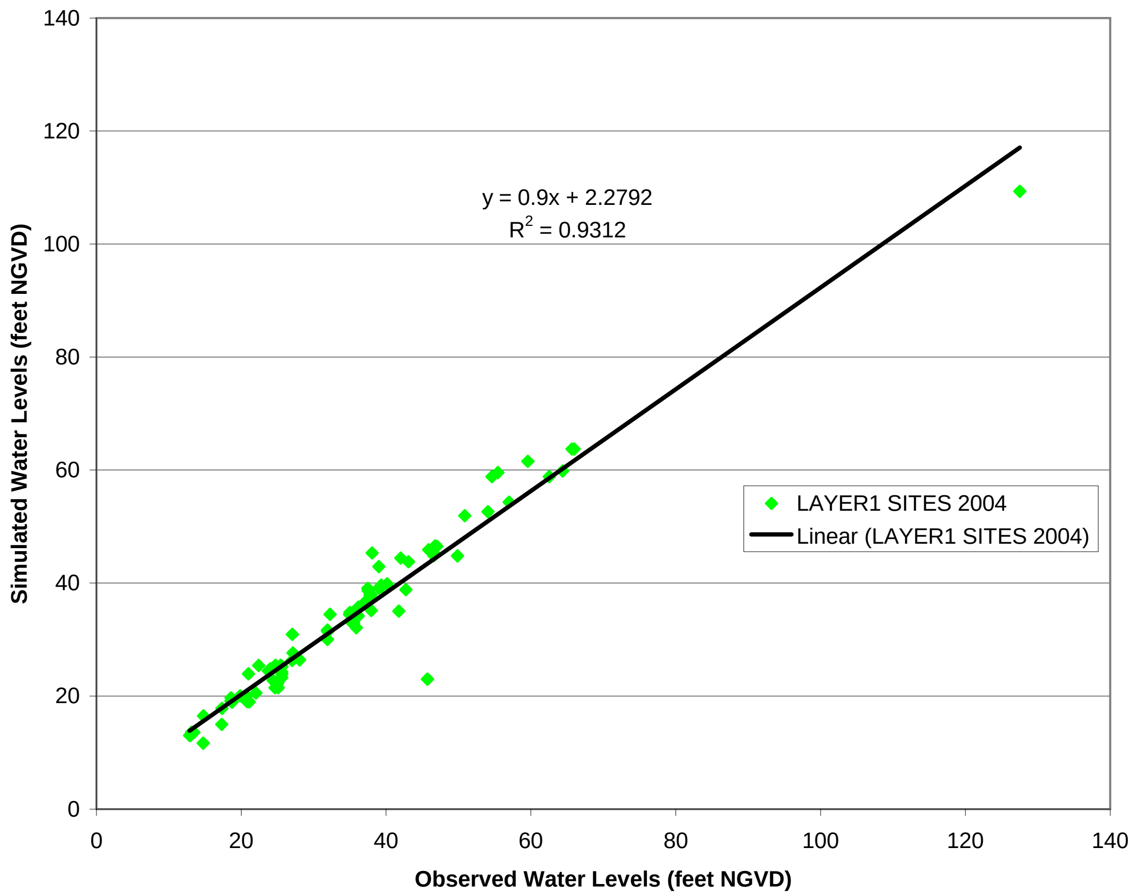

Figure 102. Observed vs. Simulated Water Levels in Observation Sites Layer 1 (2004 Conditions).

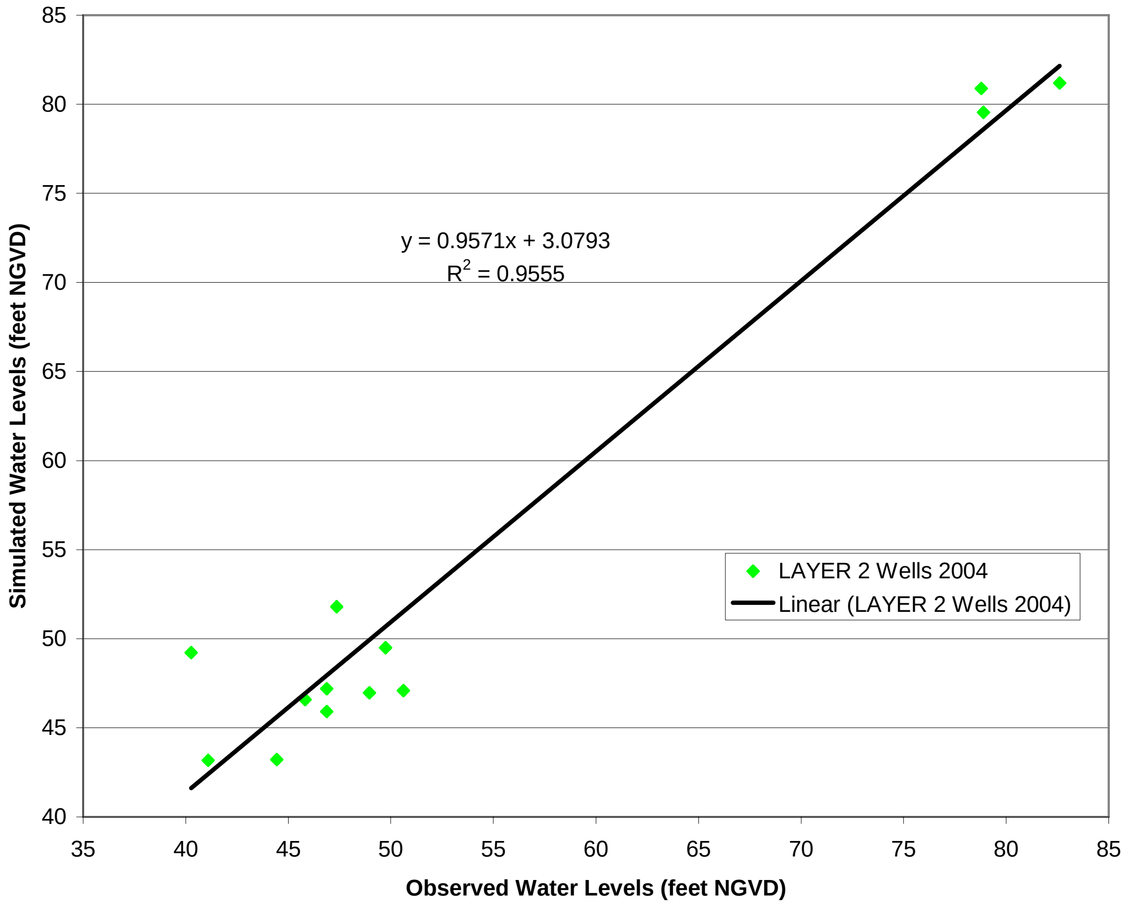

Figure 103. Observed vs. Simulated Water Levels in Observation Sites Layer 2 (2004 Conditions).

Table 24. Observed vs. Simulated Water Level 2004, Layer 1.

Layer	Row	Col	Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Avg Diff	Abs (Diff)	Met Calibration Criteria
1	2	59	KRENNM1	46.75	46.55	0.20	0.20	True
1	2	71	ELMAX_G	65.68	63.74	1.94	1.94	True
1	3	59	KREFFS	45.72	22.99	1.12	1.12	True
1	3	59	KREFFM	45.72	22.99	1.12	1.12	True
1	6	60	RATHAM	49.86	44.79	5.07	5.07	
1	12	78	MAXCEY N_G	62.54	58.84	3.70	3.70	True
1	15	64	S65AX_H	47.00	46.51	0.49	0.49	True
1	15	65	S65A_H	46.55	45.29	1.26	1.26	True
1	15	107	IR-25_G	28.06	26.42	1.64	1.64	True
1	19	48	AVON P_G	127.51	109.34	18.17	18.17	
1	21	64	C38.PINE	43.08	43.74	-0.66	0.66	True
1	24	62	FTKISS	40.15	39.87	0.28	0.28	True
1	26	61	WEIR3_H	39.34	39.65	-0.31	0.31	True
1	28	59	WEIR2_H	39.38	39.37	0.01	0.01	True
1	30	78	PEAVINE_G	64.39	59.84	4.55	4.55	
1	31	68	MAXCEYS_G	54.06	52.62	1.44	1.44	True
1	36	57	PC61_H	38.98	42.89	-3.91	3.91	True
1	38	57	PC53	37.79	37.86	-0.07	0.07	True
1	38	58	KRCFFM	37.90	37.95	-0.05	0.05	True
1	38	89	GRIFFITH_G	65.96	63.74	2.22	2.22	True
1	38	105	OK-3_G	59.56	61.53	-1.97	1.97	True
1	39	56	KRDNNM1	37.96	35.14	2.82	2.82	True
1	41	61	PC41	37.46	39.05	-1.59	1.59	True
1	41	63	MICCO_G	46.59	44.86	1.73	1.73	True
1	42	60	KRAFFS	41.76	35.02	6.74	6.74	
1	42	61	PC42	37.13	36.70	0.43	0.43	True
1	43	38	SEBRING_G	55.42	59.54	-4.12	4.12	.
1	43	59	PC44	36.19	35.77	0.42	0.42	True
1	44	63	PC32	35.96	35.20	0.76	0.76	True
1	44	65	PC31	37.93	37.88	0.05	0.05	True
1	45	55	MCARTH_G	50.87	51.90	-1.03	1.03	True
1	45	61	PC34	35.87	32.08	3.79	3.79	True
1	46	60	PC35	35.76	33.86	1.90	1.90	True
1	48	56	H-11A_G	45.85	45.88	-0.03	0.03	True
1	48	63	PC21	35.36	34.46	0.09	0.09	True
1	49	61	PC22	35.50	33.10	2.49	2.49	True
1	49	90	BASSETT_G	42.02	44.42	-2.40	2.40	True
1	50	64	PC12	35.06	33.25	1.81	1.81	True
1	50	65	PC11R	35.00	34.80	0.20	0.20	True
1	51	67	S65C_H	34.97	34.42	0.55	0.55	True
1	51	86	CYPRS	37.53	38.64	-1.11	1.11	True
1	51	103	TAYLC.O1_H	54.61	58.84	-4.23	4.23	

Table-24. Observed vs. Simulated Water Level 2004, Layer 1 (Continued).

Layer	Row	Col	Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Avg Diff	Abs (Diff)	Met Calibration Criteria
1	52	78	OK-2_G	42.72	38.82	3.90	3.90	True
1	52	81	CHAND1	32.26	34.47	-2.21	2.21	True
1	53	100	RUCKGW2	38.06	45.32	-7.26	7.26	
1	56	77	PD03F	27.13	27.62	-0.49	0.49	True
1	58	75	PD02R	27.07	30.89	-3.82	3.82	True
1	60	50	S68_H	39.01	39.12	-0.11	0.11	True
1	61	76	PD01F	27.03	26.31	0.72	0.72	True
1	61	89	FLYGW2	36.14	34.17	1.97	1.97	True
1	61	108	OPAL_G	31.95	31.44	0.51	0.51	True
1	62	100	ARS_B0_G	22.41	25.40	-2.99	2.99	True
1	64	81	YATES M_H	23.72	24.45	-0.73	0.73	True
1	65	102	TAYLC.WD	19.84	20.06	-0.22	0.22	True
1	68	56	S82_H	31.88	30.03	1.85	1.85	True
1	68	57	S83_H	31.89	31.66	0.23	0.23	True
1	73	94	G80_H	21.12	18.97	2.15	2.15	True
1	74	108	MOSQC_T	18.58	19.69	-1.11	1.11	True
1	75	85	S65E_H	20.99	23.95	-2.96	2.96	True
1	76	84	S84_H	24.04	24.83	-0.79	0.79	True
1	77	91	S154_H	22.02	20.55	1.47	1.47	True
1	77	105	S133_H	13.24	13.57	-0.33	0.33	True
1	78	112	NUBBC_H	18.73	18.90	-0.17	0.17	True
1	79	65	S75_H	25.57	25.31	0.26	0.26	True
1	79	110	S191_H	18.54	19.12	-0.58	0.58	True
1	83	119	L64C_H	20.82	19.02	1.80	1.80	True
1	86	58	BUCK13_G	24.41	22.78	1.63	1.63	True
1	86	59	BUCK15_G	24.64	21.47	3.17	3.17	True
1	86	60	BUCK19_G	24.88	21.63	3.25	3.25	True
1	87	54	BUCK01_G	25.57	24.26	1.31	1.31	True
1	87	55	BUCK06_G	25.44	25.26	0.18	0.18	True
1	87	56	BUCK07_G	25.44	25.48	-0.04	0.04	True
1	87	57	BUCK11_G	25.41	25.38	0.03	0.03	True
1	87	58	BUCK20_G	24.73	25.45	-0.72	0.72	True
1	88	54	BUCK04_G	25.62	23.91	1.71	1.71	True
1	88	55	BUCK05_G	25.63	23.26	2.37	2.37	True
1	88	56	BUCK09_G	25.05	22.32	2.73	2.73	True
1	88	57	BUCK10_G	25.09	21.50	3.59	3.59	True
1	89	61	S70_H	25.60	25.18	0.42	0.42	True
1	89	94	S127_H	13.46	13.56	-0.10	0.10	True
1	93	80	S72_H	20.68	20.00	0.68	0.68	True
1	94	122	S135_H	13.14	13.60	-0.46	0.46	True
1	101	39	H-15A_G	57.00	54.33	2.67	2.67	True
1	101	72	G76_H	17.30	14.96	2.34	2.34	True
1	102	81	S129_H	12.97	13.06	-0.09	0.09	True

Table 24. Observed vs. Simulated Water Level 2004, Layer 1 (Continued).

Layer	Row	Col	Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Avg Diff	Abs (Diff)	Met Calibration Criteria
1	109	70	S131_H	12.87	13.04	-0.17	0.17	True
1	119	63	NIOC3	17.33	17.83	-0.50	0.50	True
1	122	64	NICO1	14.75	11.67	3.08	3.08	True
1	122	66	CULV5A_H	14.80	16.52	-1.72	1.72	True
							92.13%	**82**

Table 25. Observed vs. Simulated Water Level 2004, Layer 2.

Layer	Row	Col	Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Avg Diff	Abs (Diff)	Met Calibration Criteria
2	2	59	KRENND	50.62	47.09	3.53	3.53	
2	6	84	OSF-42	44.44	43.21	1.23	1.23	True
2	10	93	OSF-60A TEST WELL AT YEEHAW JUNCTION,FL	41.10	43.17	-2.07	2.07	True
2	17	15	CLENNY DEEP NW/O AVON PK FL	82.61	81.19	1.42	1.42	True
2	30	26	BONNET LAKE DEEP NEAR SEBRING FL	78.78	80.88	-2.10	2.10	True
2	35	32	JOHN MCCULLOCH WELL 11 NEAR SEBRING FL	78.89	79.54	-0.65	0.65	True
2	43	79	727100-- 35S33E02 BASS WELL N OF BASSINGER (okf18)	45.82	46.59	-0.77	0.77	True
2	71	99	OKF-23	46.88	45.91	0.97	0.97	True
2	74	100	OKF-31_G	48.95	46.96	1.99	1.99	True
2	77	39	LAKE PLACID GROVES DEEP SOUTH OF LAKE PLACID FL	47.36	51.80	-4.44	4.44	
2	79	69	71110501OBSER WELL GL155 NEAR BRIGHTON, FL.	46.88	47.20	-0.32	0.32	True
2	116	42	65511803OBSER WELL GL267 NEAR PALMDALE, FL.	40.27	49.22	-8.95	8.95	
2	117	46	65411601 41S30E12 CLEMONS PALMDALE	49.75	49.50	0.25	0.25	True
							76.92%	**10**

Table 26. Observed vs. Simulated Water Level 2004, Layer 3.

Layer	Row	Col	Station	Average Observed Water Levels 2004	Simulated Water Levels 2004	Avg Diff	Abs (Diff)	Met Calibration Criteria
3	15	64	S-65A(POF-20)WELL NR YEEHAW JUNCTION,FL	43.74	47.22	-3.48	3.48	
3	16	38	73911801 33S30E06 USAF AVON PARK #1	72.69	74.84	-2.15	2.15	True
3	32	78	OKF-34	45.76	47.52	-1.76	1.76	True
3	51	66	OKF-42	46.94	47.48	-0.54	0.54	True
3	53	53	FTB18	46.99	49.24	-2.25	2.25	True
3	54	66	FTB20	46.79	47.49	-0.70	0.70	True
3	57	62	FTB17	47.19	47.78	-0.59	0.59	True
3	65	72	FTB19	48.15	48.03	0.12	0.12	True
3	69	39	ROMP 28 FLORIDAN WELL NR LAKE PLACID FL	69.76	68.25	1.51	1.51	True
3	73	73	FTB45	48.09	48.25	-0.16	0.16	True
							90.00%	**9**

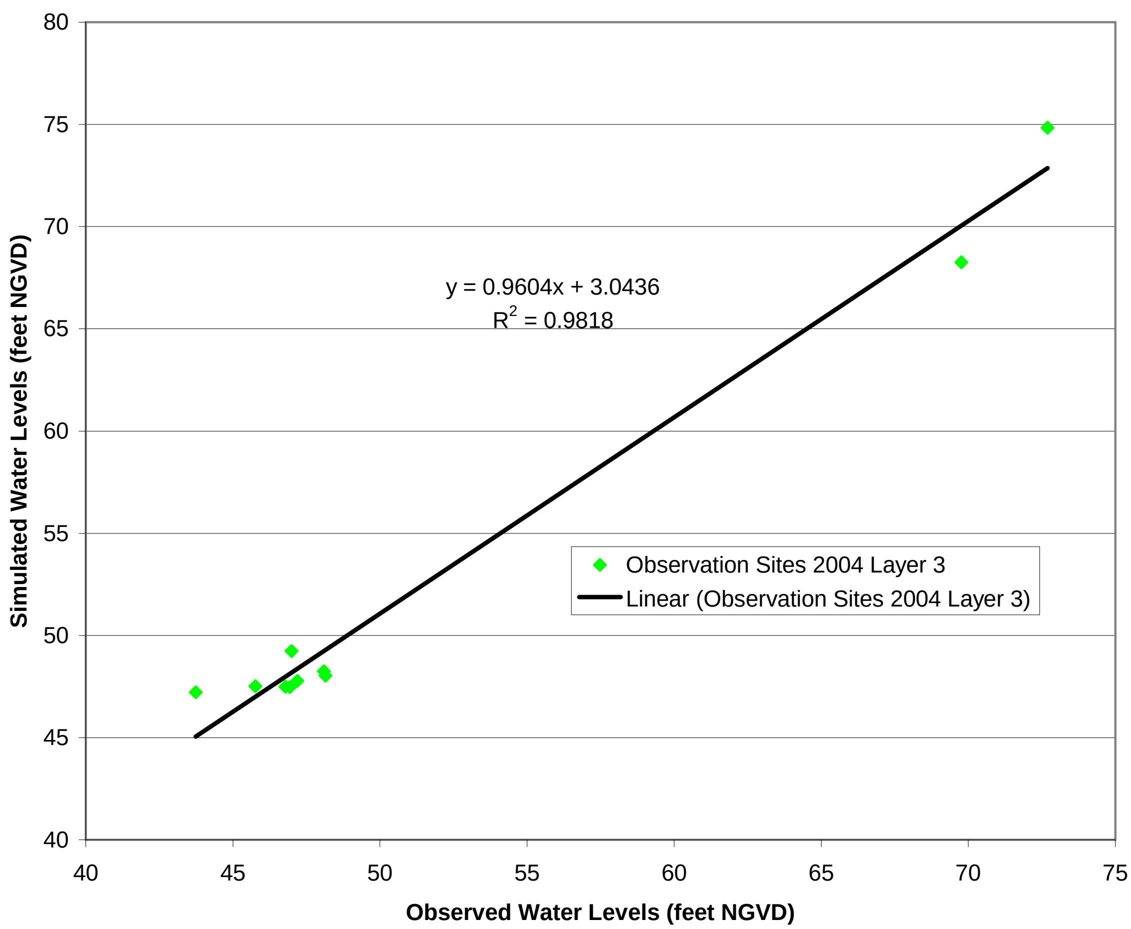

Figure 104. Observed vs. Simulated Water Levels in Observation Sites Layer 3 (2004 Conditions).

The water levels in the Surficial Aquifer System were lower in 2004 for most of the model area. Only some areas near Lake Wales Ridge had water levels that were higher in 2004 (**Figure 105**).

In the Upper Floridan Aquifer, the mean difference in water levels between 1995 and 2004 was 0.25 feet, with the water levels being lower in 2004 (**Figure 106**). In Blue Cypress Marsh, the water levels dropped by 0.75 feet for most of the marsh and up to 2 feet near the SFWMD district boundary and the boundaries of St. Lucie and Okeechobee counties.

In the Middle Floridan Aquifer, the mean difference in water levels between 1995 and 2004 was 0.14 feet, with the water levels being lower in 2004 (**Figure 107**).

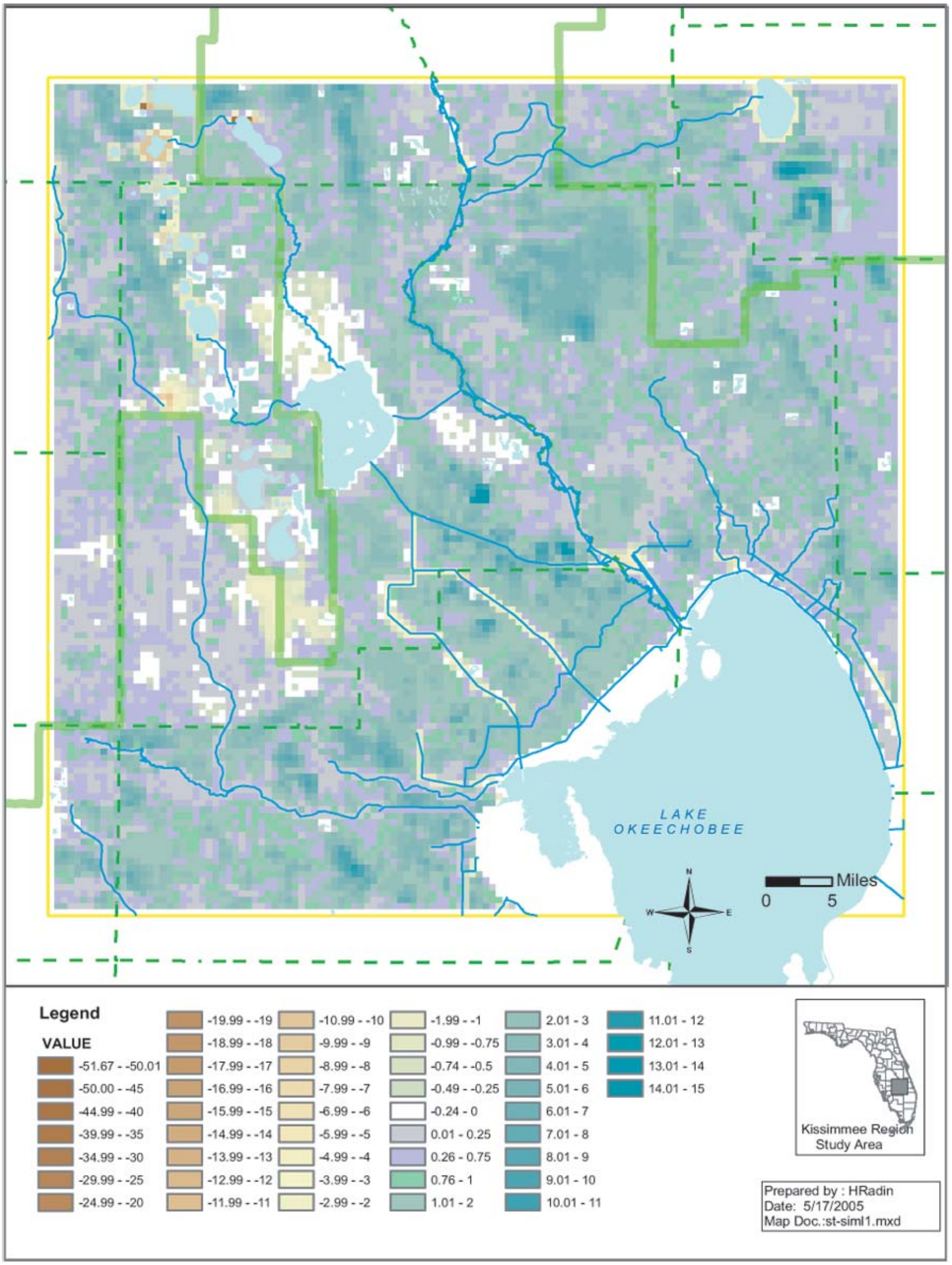

Figure 105. Difference in Water Levels 1995 AG and 2004 AG Surficial Aquifer.

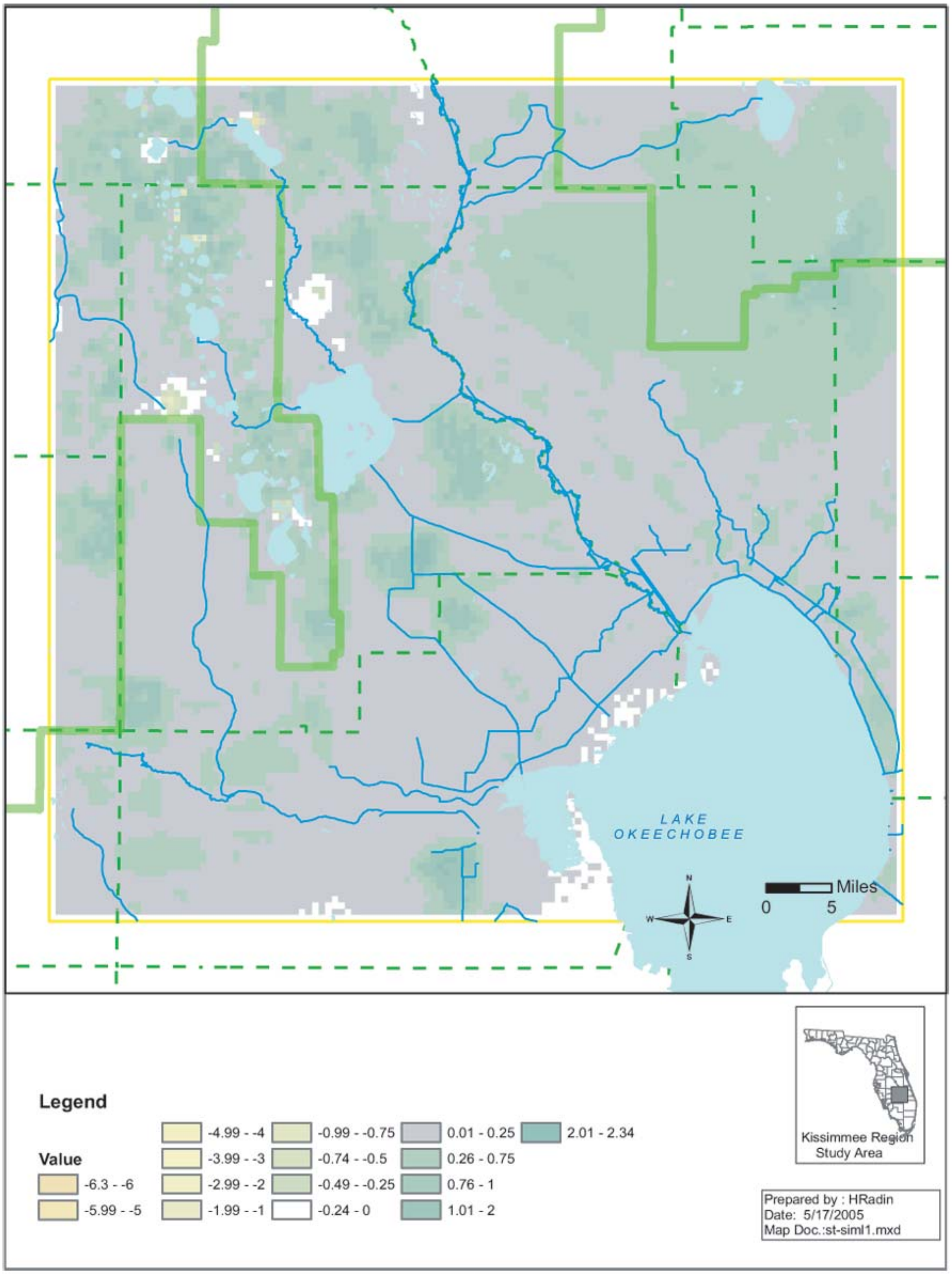

Figure 106. Difference in Water Levels 1995 AG and 2004 AG Upper Floridan Aquifer.

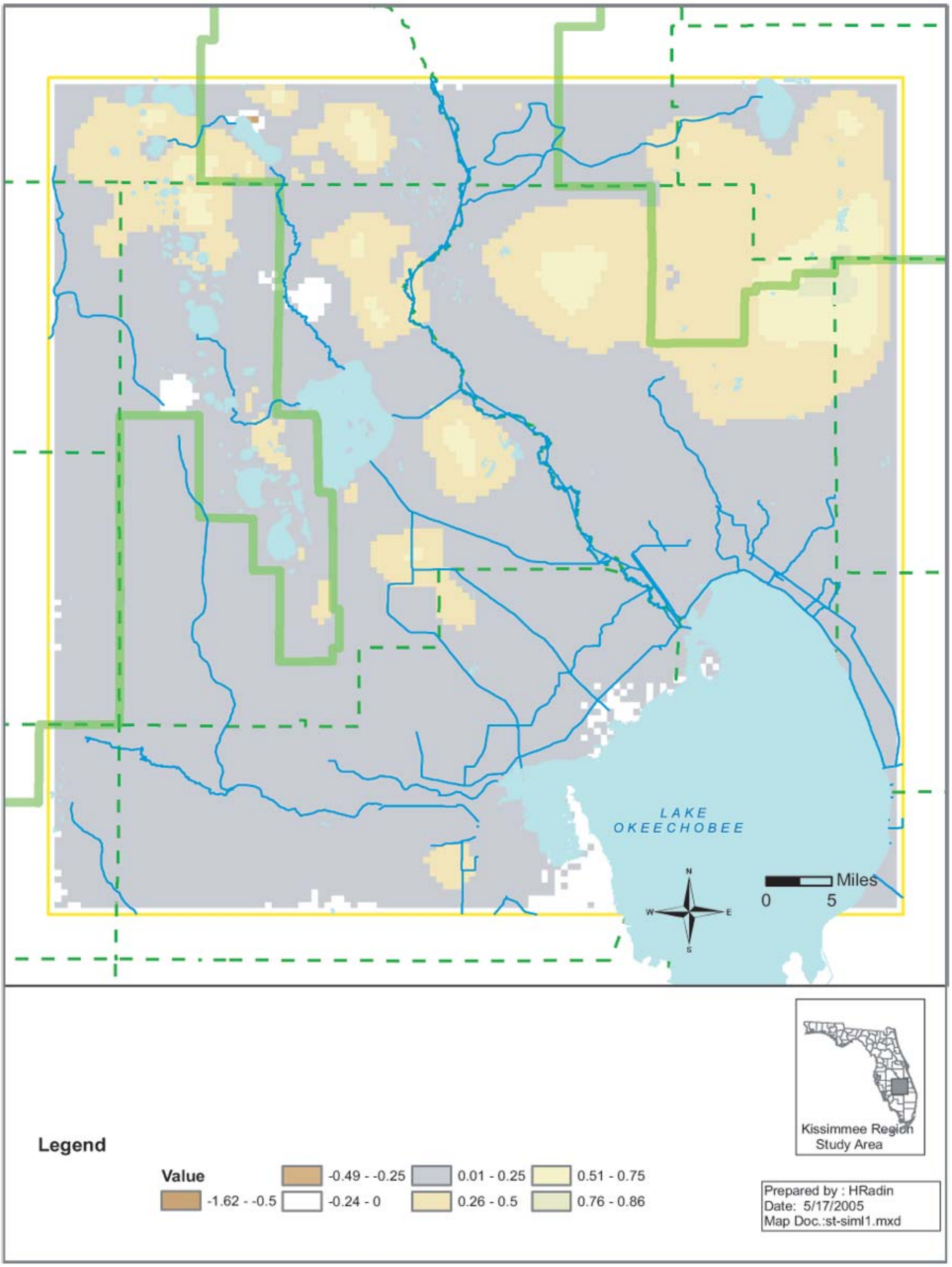

Figure 107. Difference in Water Levels 1995 AG and 2004 AG Middle Floridan Aquifer.

Model Limitations

A model is a tool used to represent an approximation of field data, and is built to assist in understanding the groundwater flow system. This model is a steady-state model and therefore, represents a state of equilibrium under averaged stresses. In reality, the stresses vary with time. The model also averages the hydrologic properties and stresses for each cell in model grid. Each cell of 2,640 ft^2 can only have one value for each property represented in the model. When the values do not vary much from the average, it does not matter, but in some cases there may be a large range of topographic relief or variability in soils that would affect evapotranspiration and recharge, and influence the simulation of the water levels in the Surficial Aquifer System. Variability of the evapotranspiration extinction depth and evapotranspiration surfaces averaged across a model cell would also have a bigger impact on the water levels in the Surficial Aquifer. The effects of the pumping stresses are also diminished when using large scale discretization vs. a finer discretization.

Another distortion occurs because MODFLOW assumes that all of the water is being pumped from the center of the cell. The MODFLOW model simplifies the hydrostratigraphy in the model area. The MODFLOW system assumes horizontal flow in the aquifers and vertical flow through the confining units. In some areas, there may be zones of preferential flow, which are not represented as layers themselves. The Intermediate Confining Unit was modeled as a confining unit, but in reality it may have areas of confinement and areas in which it behaves more as an aquifer.

The model results are limited by the accuracy of the input data. The evapotranspiration values were estimated using temperature data from points and applying the value for a whole Thiessen polygon. Average rainfall data for 1995 were used for the calibration and also were applied to Thiessen polygons. Agricultural consumptive use is not metered within the SFWMD, therefore stresses needed to be estimated. For model calibration, permitted water use values were used. For the predictive runs, the stresses were estimated based on land use and crop type. Few geologic logs were available in the model area to obtain hydrostratigraphic data, so most hydraulic conductivity, transmissivity and even the picks for the tops and bottom of the layers were estimated. The sparse point data available needed to be interpolated into surface data to be used in the models.